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The Contractor in Foreign Fields

A MOST important announcement is that contained in the interview in the news section of this issue with Willard Straight, formerly of the firm of J. P. Morgan & Company and now vice-president of the American International Corporation, the $50,000,000 company recently formed for exploitation in the foreign field. He points out that there is now available a way through which American contracting firms can enter the foreign field with assurance that the handling of the securities they must take will impose no grave obstacles. Opportunities for trade extension in the foreign field have been fairly well understood, but contractors, with few exceptions, have not known just what to expect when they engaged in foreign work. Certainly their activities should be apace with the manufacturers, and Mr. Straight's words are sure to direct their attention in this promising direction.

An Unusual Convention

THE Third National Foreign Trade convention, which will be held in New Orleans Jan. 27 to 29 under the auspices of the National Foreign Trade Council, will be a meeting of quite unusual character. Instead of indulging in the platitudes which are usually expected at a gathering of this sort, the entire meeting is to be predicated on the acceptance of proved principles of foreign trade. Instead of arguing the necessity of adequate banking facilities and transportation, adaptation of product and sales methods to market, proper packing, knowledge of foreign tariffs and the relation of investment to export trade, the papers and discussions will relate to the *practical application* of these principles. Moreover, trade experts, some of them from the Federal Department of Commerce, will be on hand to give specific advice on foreign trade questions. The meeting would be a good one for American contractors considering entry into the foreign field to attend.

Pan-American Congress

DURING the two weeks ended last Saturday the newspapers of the country devoted space almost daily to the meetings of the Pan-American Scientific Congress, which met in Washington. The reports, generally, emphasized not the scientific but the international aspects of the gatherings, and in so doing they gave a correct picture, in the main, of the activities of the congress. While there were scientific sessions of interest, they were overshadowed by the international questions which were the topics for the general sessions, and which kept cropping up in the section sessions and in the corridor discussions. The Secretary of State voiced the keynote in his now famous "one for all, and all for one" speech on Pan-American unity, while the President, near the close of the congress, announced the principles which, in his judgment, should form the basis for an agreement between the American republics. It is patent that nothing is being left undone to cement the bonds between the 'three Americas." The congress, therefore, in its larger aspects is but a part of the whole general movement, of which the Pan-American Financial Congress held in Washington last May was the beginning. Any intercourse, even if it be merely scientific and literary, cannot but aid in bettering international relations, and this byproduct may be of greater value in time than the immediate gain from the interchange of ideas. Ultimately, too, a clear insight by nations into each other's intellectual points of view is bound to develop sympathy and confidence, and these in turn are the surest foundations for permanent commercial relations.

Paint as a Conserver of Light

ENGINEERS are apt to overlook the fact that the type of illuminant they install in factories, railroad stations, and other buildings is only one factor in the solution of the lighting problem. A neglected element, discussed by Henry A. Gardner, assistant director of the Institute of Industrial Research, of Washington, in a paper before the Master House Painters and Decorators' Association Jan. 10, is the color of the interior surfaces. In industrial establishments increased output, improved workmanship and fewer accidents have resulted where better lighting systems have been installed. In such places, wall treatment as a means of conserving the illumination has generally been adopted. These advances have come as a result of practical observations, which show that the rays from powerful lights, falling upon dark brick or stone walls, give less light to a room than the rays from less powerful lights falling upon similar walls that have been painted in light colors with dust-resisting, washable paints. Moreover, the monthly cost of illuminants for lighting dark-walled factories may be enormously reduced by the occasional application of such paints.

Accession to the Safety Movement

ANY large addition to the long list of those who are actively working for greater safety on streets and highways is to be heartily welcomed, but when the addition is that of an industry whose product has largely contributed to the increase in the number of accidents there is special reason for satisfaction. Last week the National Automobile Chamber of Commerce, meeting in New York, appointed a Safety First Committee, which not only will engage in general publicity to curb reckless driving, but will exercise its influence to impress on automobile dealers and manufacturers the need for sane driving if the automobile industry is to escape severe censure and harmful and unnecessary restrictive legislation. In the past, some of the members of the chamber admitted, dealers and manufacturers have strongly opposed perfectly justifiable restrictions, drawn up for safeguarding pedestrians. This course, manifestly, is shortsighted, for it results in encouraging the reckless to continue to disregard the rights of others. Inevitably there would result legislation which might become a serious bar to the most effective, yet reasonable, use of the motor car. The manufacturers who are members of the chamber are broad enough to see this. It will be to their own interests and those of the public at large if they succeed in impressing their views upon everyone engaged in the automobile industry.

Cheap Insurance for Employees

THE Brooklyn Rapid Transit Company of New York City, taking advantage of the fact that the collective insurance premiums of its employees amount to a large sum, has secured for them at their option what is said to be the cheapest life insurance ever offered under a group plan. For men under 32, the annual premium on $1,000 is only $7.28. Furthermore, one-half of the premium is paid by the company and no physical examination is required if the employee applies for his insurance within six months of the date his length of service (two years) permits him so to apply. When a man is retired on pension the company assumes his premiums, so that he has a paid-up policy at that time. Should he leave the employ of the company for any reason, he can convert his insurance practically at its face value, including the premiums paid by the company, into a standard life or endowment policy without physical examination. Already 65 per cent of this company's employees have availed themselves of this arrangement to take out policies on which their share of the premium will be $28,000 annually. A like sum to be spent annually by the company will prove to be a good investment. It is a very encouraging sign to see the management of a large public-service corporation appreciating the value of spending a little money and effort in the interests of its employees. Action of this kind is well worth the study of engineers and contractors handling large numbers of men.

Steel Column Test Series

THE REPORT of progress made in the extensive series of steel column tests being conducted by a special committee of the American Society of Civil Engineers and the American Railway Engineering Association, while emphasizing one noteworthy result in the evident relative weakness found for columns of thicker material, still leaves the impression that the great mass of scientific data which has been obtained in the conduct of these tests at the Bureau of Standards remains comparatively untouched.

As pointed out in the editorial published in this journal May 8, page 574, a thorough analysis of results should progress with the tests, in order that any apparent laws may be observed early and the series modified to give more definite evidence, if necessary. The modification in the method of testing there suggested—carrying the load up repeatedly to the same unit stress to determine evidence of progressive set, which should be considered as marking the life limit of the column—is believed to be so important that it should again be emphasized. The committee recognizes the vital influence of the yield point on column strength, and yet the determination of that point, or of the true elastic limit, is confessedly impracticable from the results of tests conducted as these have been.

This journal further questions whether the purposes in view can be best accomplished through a large committee of well-qualified, but busy, engineers who very probably cannot make the careful analysis so needful for full returns from the time and money expended on this elaborate investigation. Is the situation not one which would warrant the engagement of a consulting engineer at a suitable compensation for the critical study of these tests as soon as the results become available, one who would stand in the relation of technical counselor to the committee? The society is in excellent condition to lend liberal financial support to this important investigation. The columns themselves having been furnished by others, it is particularly incumbent upon the society to see that the analysis of the results shall be the best and most thorough possible, and that the tests yet to be made shall be conducted in the light of any new knowledge gained from previous observations.

Progress of Structural Design

THIS country has passed through a period in which there has been an abundance of raw material and in which a manufacturing plant with any reasonable degree of efficiency could operate at a profit. Raw materials have now become less abundant and a manufacturer must operate with a high degree of efficiency in order to survive. This change in conditions is affecting structural engineering as well as other lines of endeavor.

Too many structures are designed in such haste that proper attention is not given to their general scheme. Not only may such a policy result in expensive and poorly planned structures, but it may actually postpone the date at which the structure is completed. One hundred dollars spent in perfecting plans may save $1,000 in the construction. This is well illustrated by the plans submitted for the two floating cranes for the Panama Canal. The prices per ton bid by the German firm and by the American firm were practically the same, but for the total, the German bid was $871,300 and the American bid $1,450,000, a difference of $578,700. The lighter structure was also considered to be superior to the heavier one. The fact that one crane failed under test load was due to the failure of one member rather than because of any inferiority in the general design. This is an extreme example, but it illustrates the saving that may be obtained by carefully planning a structure.

Not only must the general scheme of a design be good, but the design must be carried out so as to result in a safe and economical structure. In order to design such a structure, it is necessary to determine the stress to which a member is subject and it is necessary to know the stress which a member will resist.

The secondary stress in a member may be as great as 50 per cent of the primary stress. If only the primary stress be considered the safety of the structure is involved. When it is difficult to determine the stress in a member, the section is often made much greater than is necessary and material is wasted. Good engineering is insurance against failure; wasted material is a tribute to ignorance. The difficulty of making an exact determination of stresses is much overestimated. To be sure it requires mathematical ability and patience, but when once the methods are mastered they seem no more difficult than many other mathematical processes. One objection to the use of the more exact analyses is the fact that they are often based upon assumptions which have not been verified by tests. This objection is valid and it is important that such tests be made.

Large structures have been destroyed through the failure of some relatively unimportant member and investigations have shown that failure was due to the inability of the member to carry the load for which it was designed. The failure of the floating crane for the Panama Canal referred to above is a striking illustration of such an occurrence. Professor McKibben has proved by tests that an angle connected by rivets through one leg can develop from 75 to 80 per cent of the strength of the net area of its section. There is but little information relative to the strength of the built-up sections usually used. No one knows their exact strength, and no one knows which ones are the most efficient. Yet the amount of material used in such members is so great that if a small fraction of one per cent of its cost were available for tests it would be possible to determine with some assurance the types of members which should be used.

It is true that time is often an important element in construction work, but the portion of the total time which is devoted to the preliminary design is so small and the opportunities to effect a saving and to produce a better structure are so great that undue haste is not justifiable in this part of the work. While it is true that it does not pay to fuss over the analysis of unimportant details, neglect of the more important parts may result in unsafe structures and in a waste of material. The structural engineer must discriminate between that which is and that which is not important enough to warrant careful investigation.

Progress in structural engineering, therefore, evidently requires a more careful consideration of the general scheme of structures, a more exact analysis of the stresses, the experimental determination of the accuracy of the assumptions upon which the analyses are based, and the experimental determination of the strength of full size built-up members.

Allocating Maintenance Between Classes of Service

IN CONNECTION with the recent Western passenger-rate case the Interstate Commerce Commission went extensively into the matter of allocating maintenance-of-way expenses between passenger and freight service. No less than twelve different methods were considered, giving passenger percentages of the total ranging from 45 per cent down to 17 per cent. Six methods were suggested by the carriers and six by the state commissions, although each faction chose one of the six as its preference.

It appears to this journal that all concerned could profitably look further into the report of W. J. Wilgus in the Ulster & Delaware case, abstracted in the Engineering Record of Aug. 21, 1915, page 226. Strange enough, the state-commission method, using the gross ton-mile as the basis, is most nearly that of Mr. Wilgus. The carriers, believing that the higher speed of the passenger train should be regarded as causing greater destruction to track, advocate the locomotive ton-mile, which, because as much locomotive tonnage is required to haul a light train at high speed as a heavy one at low speed, makes the passenger train a bigger factor in maintenance. But while the speed factor is important, Mr. Wilgus made it very clear that there were potent arguments on the other side of the case, such as drippings, imperfections of freight equipment, and heavier wheel concentrations. It would unquestionably be well if a means could be devised of measuring the comparative effect of these things, but certainly the railroads are not making a scientific argument when they disregard all of the destructive forces peculiar to freight service.

While the Interstate Commerce Commission evidently leans toward the ton-mile method, it thinks the facts and arguments presented are insufficient to warrant the approval of either of the methods. Perhaps one reason is that the state commissions did not, judging from the national commission's report, fully develop the fact that the application of the ton-mile basis is limited to certain of the items of maintenance, and that more than one other basis should be used for other items. The states did, it is true, show their realization of this in two of their methods, charging wear to the gross ton-mile and weather to either the car-mile or the net ton-mile. The report states, however, that the assumptions are not convincing. It does not say just how they were applied, and how the different maintenance items were divided and classified. The Engineering Record suspects, however, that it was not done with the completeness that characterizes the Ulster & Delaware study, and again suggests that all interested in the subject give Mr. Wilgus' report another careful reading.

The Evolution of the Aeroplane

ONE of the things which can be placed on the credit side of the ledger of the present European war is the evolution of the heavier-than-air flying machine from a sporting device to an every-day, hard-working necessity. When one reads the repeated accounts of raids by bomb-carrying aeroplanes in squadons ranging from a dozen to several score, working in long flights over the enemy's country, and generally returning unscathed, one awakes to a sudden realization that the great feat of conquest of the air is very near to being an accomplished fact. Now and then, of course, in a furious raid an engine goes wrong or a plane is hit by flying shrapnel or machine gun bullets, but on the whole the number of casualties, considering the risks from projectiles, is astonishingly small. It seems to be nothing uncommon for a squadron to depart, drop a hundred bombs or so on an enemy's position fifty or a hundred miles away and come back complete to patch a few rents in the wings and be off again the next day.

Even during the past year of active hostilities the evolution of the plane as a reliable machine for the hardest kind of scouting purposes has proceeded at an astonishing rate. At first the aviators were unarmed save for service rifles or automatic pistols, and the fusilage was quite unprotected. Within a few months came light armor for the vulnerable parts and a light machine gun for offence. Armoring the aeroplane would seem at first rather a difficult task, and so indeed it would be if the machines were to be exposed to rifle fire at short range. A modern army rifle bullet will penetrate a half inch of boiler plate, but a machine high in air catches the bullets, if at all, at a greatly reduced velocity and almost always at quite oblique incidence, so that a comparatively thin sheet of carefully tempered steel will give adequate protection. Even shrapnel bullets and fragments of shell have still less penetrating power, so that armoring under service conditions has proved to be a rather simple matter.

Means of offence have also increased with equal rapidity. Powerful machine guns are now regularly mounted on war planes, together with suitable devices for dropping incendiary and high explosive bombs, but the time seems now at hand when still further evolution in power of offence and defence is at hand. The Russians are reported to have developed some giant flying machines with double fusilage and engines of much greater power than hitherto tried. The French are known to have similar equipment under way, and even in this country experiments along the same line have been actively carried out. If these prove as successful as there is reason to expect, the next year of war will see armored aeroplanes capable of flying hundreds of miles at great speed while carrying half a ton or more of explosive. Even now some of the largest French planes are equipped with one-pounder rapid fire guns, and these probably will be replaced with light cannon of still larger caliber ere long. Thus armed and armored, the heavier-than-air machine becomes formidable either for offence, or for defence against raiding air craft of various sorts.

England is also reputed to be building air craft of great power in large numbers. In view of all this it seems reasonably certain that by the end of the war the aeroplane will be in position to take its place as a rather reliable means of emergency transportation, perhaps even as an aerial vehicle capable of performing regular service at high speed. The change which the year has produced is of a very startling character and another year will bring still further surprises. It is certainly the duty of engineers and aviators in our own country to see to it that we are not left behind in the race for command of the air.

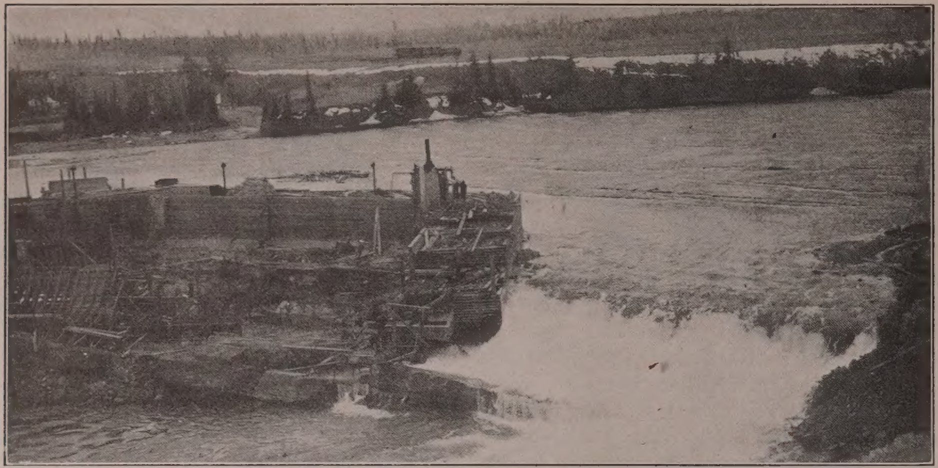
The Engineer in Administration

A PAPER read by Dr. Hollis Godfrey before the American Society of Mechanical Engineers last month brings to the front the importance of orderly engineering methods, skillfully applied, in the administration of large affairs. Those who have charge of the policies of important organizations necessarily see them chiefly from the inside and when, as often happens, they call for the assistance of the engineer with respect to details of work in hand, what they chiefly require, although they may not put it to themselves in precisely that way, is the broad view of a trained mind working from the outside, quite as much as technical resources in dealing with special matters. It is the business of the engineer in such a case to coordinate the facts which are to serve as a basis of his judgment, and to organize them in such way as to show directly their bearing on the policy and success of the business to which they are related. If petty details alone were to be concerned, almost every large concern has within its own staff plenty of ability for dealing with them.

Mr. Godfrey presents the tasks of the consulting engineer, called in to look at affairs from the larger view point, in a most effective and orderly fashion, putting into words the methods which the trained mind follows almost instinctively and setting them forth so that their relation can be plainly seen. The examples of such organized study which Mr. Godfrey gives are well worth investigation by every young engineer applying his training to intricate concrete problems. The schedule drawn up to deal with the study of street lighting is a type of that which might be used, with its terms changed, in the investigation of many another engineering problem. In the mind of an experienced investigator like Mr. Godfrey such a codification leads to speedy and accurate conclusions, although one should properly add a word of warning lest lack of a proper sense of proportion as to the importance of the various items may lead to the waste of a great deal of good and valuable time in ascertaining to an unnecessary degree of precision details which are of secondary importance. This is the danger that besets the comparatively inexperienced in dealing with large tasks in engineering. Just as over-devotion to an efficiency system may lead to mazes of red tape that actually impede the doing of business, so somewhat slavish adherence to a schedule may result in a costly accumulation of minor facts that are only incidentally needful. That Mr. Godfrey clearly appreciates these limitations is evident from his paper, yet it is not amiss to call attention to them. One of the old jokes launched at the patient German investigator was that in measuring a base line he was prone to run off ninety-nine one-hundredths of it with a yard stick and then finish it up with a micrometer screw held rigorously at constant temperature.

The skilled engineer, like the really skilled mechanic, knows by experience or instinct where to go in for extreme precision, and where to save labor by carrying his work only so far as is necessary. To appreciate the difference, however, just the systematic attack on the task that Mr. Godfrey sets forth is necessary as a preliminary. The preliminary work having been done the conclusions must be drawn up in such form as to be of definite use and one may well emphasize the suggestions of brevity and clarity which Mr. Godfrey makes.

It is hard to lay too much stress on the necessity for the expression of facts in clear concise English, without long winded digressions, and without beating about the bush. In reading an engineer's report it should be possible to see exactly what is mean and to appreciate at once the bearing of the facts upon their use. Reports of this kind are unhappily all too rare. There is a place in an engineering work even for elaborate details which may be at some time of large value, but it is the bearing of these on the general conclusions which is the important matter from the standpoint of the executive who wants advice and not mere erudition. The young engineer can very profitably study this discussion of Mr. Godfrey's and take much of its contents to heart in his daily life.



DAM WAS BUILT IN THREE SECTIONS MAINLY ON ROCK LEDGE

Five Schemes Considered for Power Development at Kananaskis Falls, Alberta

Part 1—Reasons Indicated for Adoption of the Plan Selected—Objections to Others Carefully Analyzed—Time Element Important

By HAROLD S. JOHNSTON
Banff, Alberta, Canada

IN ORDER to supplement the service of its Horseshoe Falls plant, which was described in the Engineering Record of Feb. 7, 1914, page 152, the Calgary Power Company, of Calgary, Alta., after carefully weighing the advantages of five different schemes, designed and constructed a 11,600-hp. plant at Kananaskis Falls. The time element had considerable weight in the decision as to the plan to adopt, as it was necessary to have the work completed in a limited time in order to fulfill contracts that the first plant could not take care of alone. Protection against ice damage had to be provided, and a tunnel was run through the dam sections to permit observation of possible percolation and to take care of uplift action from water underneath. The lining of the canal was carefully considered on account of the ice danger.

The Kananaskis Falls plant is situated on the Bow River about 54 miles from Calgary, directly below its junction with the Kananaskis River. It is about two miles upstream from the Horseshoe Falls plant. The latter plant supplied power to the City of Calgary and to two cement mills of the Canada Cement Company, one in Calgary, and one in Exshaw, 8 miles distance. It had sufficient machinery to supply all immediate demands, but the low-water flow, which averaged about 800 sec.-ft., was insufficient.

REASONS FOR SELECTING KANANASKIS FALLS

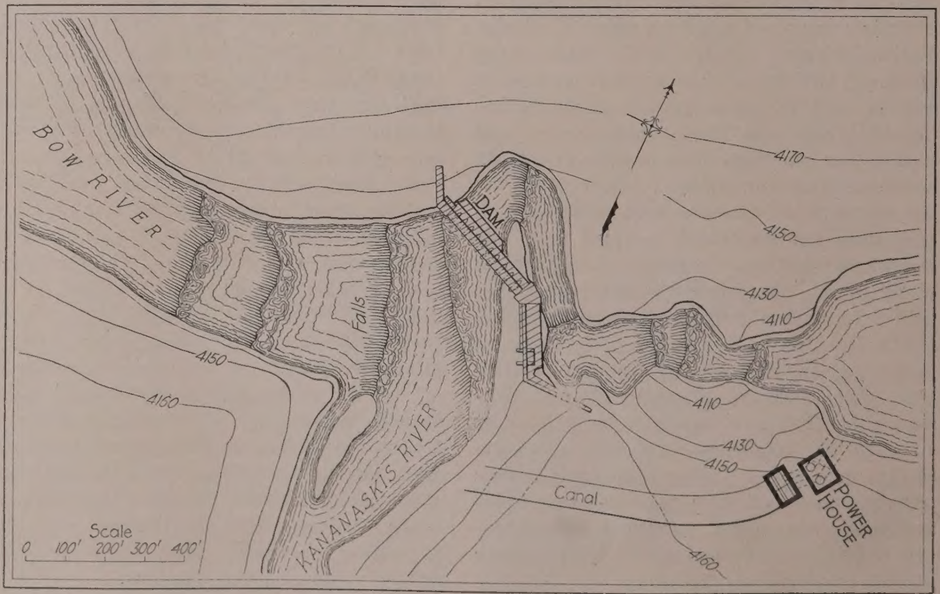
Main storage-reservoir sites were available at three points above the Kananaskis Falls plant, of which one, at Lake Minnewanka, on the Cascade River, a tributary of the Bow, and 33 miles distant from the plant, has been developed to the extent of 44,000 acre-feet. The other sites were at Spray Lakes, 60 miles away, and at Bow Lake, 90 miles away.

It had been found that it would be difficult to obtain a regulation that would make economical use of the Lake Minnewanka storage, because the released water takes a minimum of eighteen hours to reach the plant, and also because of the low winter temperature. If all these storages could have been developed, and gave maximum efficiency, it would have been possible to obtain a continuous low-water flow of 1500 sec.-ft. The creation of such storages would have been a lengthy process, however, and it was doubtful whether an efficiency of more than 6 per cent could have been obtained until a few years had elapsed to give the necessary data for more economical regulation. To develop the Spray and Bow Lake storages would have cost $625,000, and the construction period would have covered possibly two years. Besides, even with a regulated flow of 1500 sec.-ft., after all available main storages had been built there could have been no absolute certainty of being able continuously to fulfill contracts made for power delivery from the Horseshoe Falls plant alone.

In addition it is the recommended policy of the Department of the Interior of the Dominion Government to develop these storages under federal auspices and control. Consequently, when an additional source of power had to be obtained to fulfill contracts made for power delivery during the low-water season, the company proceeded with the construction of the Kananaskis Falls plant. This would give a known and assured amount of power in contrast with placing dependence on the questionable efficiency of distant storages which would probably, in any case, be developed in a few years under government auspices. When that time came, both plants would reap the benefit of whatever increase there might be in the low-period flow. This double increase of power output would also come at a time when Calgary's demands, and those of the industrial plants had increased to a point where more power would be necessary than could be guaranteed throughout the whole year.

FALLS CONSIDERED MOST FEASIBLE OF SIX SITES AVAILABLE

Kananaskis Falls forms the most interesting, most feasible and cheapest power site of six which are available on the Bow River between there and the city. Bow River rises in Bow Lake in the Rocky Mountains, near the Continental Divide, and flows southeast to the foothills, and thence easterly and, later, southeasterly through the foothills and the prairie to its junction with the South Saskatchewan River in southern Alberta, about 300 miles from its source. The drainage area above Kananaskis Falls is 1990 square miles and may be considered as lying entirely within the mountains. The mean yearly precipitation at Calgary, on the prairie, is 16 in., averaged from a period of twenty-nine years, and at Banff, in the mountains, 30 miles distant, 19 in. for a period of nineteen years. The mean temperatures at the site are 60 deg. Fahr. in July and 13 deg. Fahr. in January, with extremes greatly above and below these temperatures—45 deg. below zero having been recorded as an instance. The maximum flood discharge recorded is 14,770 sec.-ft. on June 24, 1911. On Jan. 24, 1911, a minimum of 590 sec.-ft. was noted. Records are not available over a long period of years, but from general data in relation to extreme floods it is estimated that in 1879 the maximum flood of 40,000 sec.-ft. occurred. Hence the ratio between maximum and minimum flow is



DEVELOPMENT IS AT JUNCTION OF BOW AND KANANASKIS RIVERS about 80 to 1, a ratio typical of mountain streams, but abnormal in this instance.

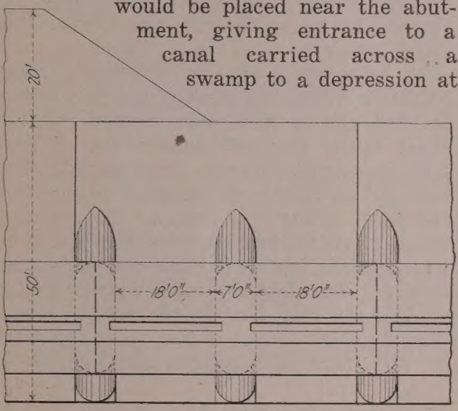
Rights to proceed with construction were not obtained until Nov. 25, 1912. On account of the contracts made for power delivery it was essential that the plant should be in operation not later than December, 1913. It was also essential that the plant should be capable of operating in parallel with the plant at Horseshoe Falls.

The total fall in the stream is 55 ft. The Canadian Pacific Railway crosses the Kananaskis River about 700 ft. above the canal and the Bow River about three-quarters of a mile above the falls.

Five Schemes Considered

Five main schemes of development were proposed for purposes of study.

The first proposed a dam which, at the center of the river, would swing across it at right angles to the stream. An intake would be placed near the abutment, giving entrance to a canal carried across a swamp to a depression at El. 4112, where the combined head works and power house would be placed with horizontal shaft turbines submerged in open vertical cylinders. The concrete draft tubes would discharge into the bay uninfluenced by the stream flow.



PIERS AND OPENINGS IN THIRD SECTION

The objections to this scheme were: The necessity of two cofferdams—one above and one below the section of dam crossing the river—on a very rough bottom, marred by potholes, and affording small chance of examination; the line of the canal crossing a swamp; the necessity of bridges for the transportation of all machinery, construction plant, and the consequent awkwardness of construction on both sides of the river; and the time element.

By the second scheme the power house, with floor level at El. 4160, would be located at the beginning of the canal, as shown on the contour map, on the bank of the Kananaskis River, with vertical shaft turbines set in wheel pits at El. 4100, discharging through the draft tubes into a tailrace tunnel with the exit in the vicinity of the sharp point below the lower falls.

The objections to this scheme were: The long vertical shaft from turbines to generators, which turbine manufacturers deprecated, feeling that vibratory effects would be serious, and the 650-ft. tailrace tunnel, which would be difficult of access.

By the third scheme an intake works would be placed at the same point as the power house in the second scheme, giving entrance to a pressure tunnel, and to concrete scroll chambers for vertical shaft turbines set between contours 25 and 30 on the flat opposite the lower falls, with the discharge from the draft tubes carried into a tailrace in the deeply indented bay. Tunnels of a size such as would be impracticable in view of the fact that the rock is Benton shale, very seamy and friable, with occasional layers of cardium sandstone, would be required in the working out of this scheme, and the test pits showed that near the site of the power house they would not have sufficient cover, particularly in view of their being pressure tunnels.

Scheme Proposed After Work Was Started

The fourth scheme was not proposed at the same time as the others. A plan had been adopted and construction started when a consulting engineer arrived at the work, having been unavoidably delayed. He proposed a horizontal-arch gravity-section dam located with subtangents just above the lower falls, with the head works a continuation of the dam, and in the same structure as the power house, which would be at the edge of the river bank. The penstocks would be of steel surrounded with concrete.

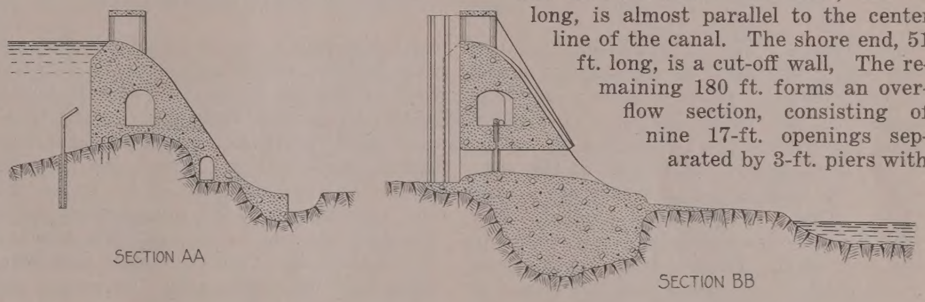
Objections to this plan were as follows: Soundings showed a depth of 40 ft. as a maximum in the pool just below the lower falls where the main section of the dam would be located; the cofferdamming of this pool and its pumping out for exploration and concrete work would be most expensive and time-consuming; the cofferdam would be of considerable length, and built on gravel at some distance below the pool to get reasonably shallow water; a sluiceway or tunnel would have to be left through the dam for passing the flood from May 15 to Sept. 15, leaving two months to do the work outlined in the first objection, which was too short, and the scheme was believed by officials of the company to be as expensive as, and probably more expensive than, the scheme adopted. It had many recognized and outstanding advantages, but time was a controlling feature, and there were many unknown conditions in connection with the dam foundations at an essential point that would be most vexatious and time-consuming.

Plan Adopted

The layout adopted called for a dam located mainly on a ledge of rock extending almost across the river. The dam is built in three main sections. The water, by this means, is raised into a canal with rock bottom by which it is conducted to an intake works with the necessary racks and gates. From here it is conveyed, in pressure tunnels lined with concrete, to vertical shaft wheels placed in concrete scroll chambers, and, thence, by concrete draft tubes to two tailrace tunnels 156 ft. long and discharged into the Bow River in a protected bay.

Some of the reasons for the adoption of this layout will be apparent from the other schemes proposed, and more will develop with further description.

The first section of the dam, 321 ft. long, is almost parallel to the center line of the canal. The shore end, 51 ft. long, is a cut-off wall. The remaining 180 ft. forms an overflow section, consisting of nine 17-ft. openings separated by 3-ft. piers with the crest elevation at 4155, the normal pond elevation.



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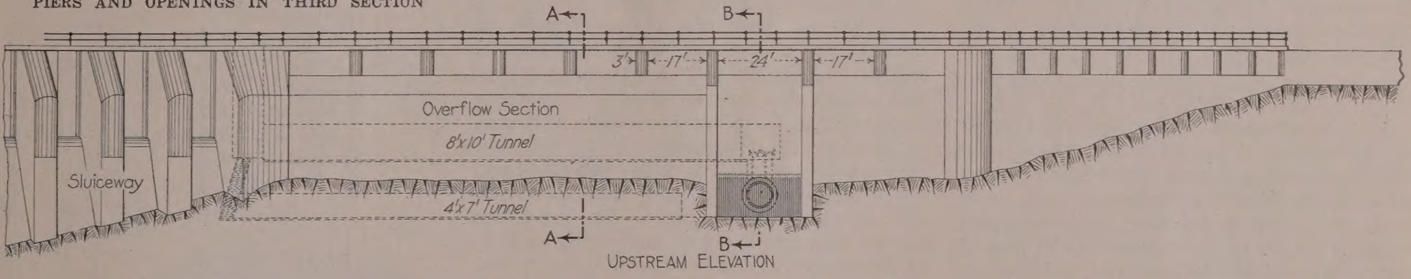


UPSTREAM ELEVATION

TUNNEL BUILT IN DAM TO PERMIT OBSERVATIONS OF SEEPAGE AND RELIEVE UPLIFT ACTION DUE TO PERCOLATION UNDERNEATH

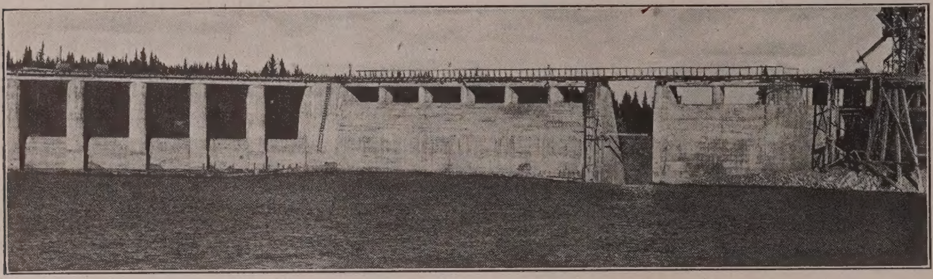
The spillway crest is fitted with 1½-in. pipe set into the concrete, to be used for the insertion of soft-iron flashboard pins which will support flashboards raising the pond elevation to 4155.75, giving 300 sec.-ft. of water for five hours during peak periods. A concrete deck 10 ft. wide covers this section.

Central Section of Dam

The central section from angle block to angle block is 184 ft. long and is provided with eight 17-ft. overflow openings, similar to the first section, and a 24-ft. opening intended for a log run. The section was built partly on and partly beyond the ledge of rock, the greatest economy in the use of concrete being sought. As first designed it lacked the 5 ft. at the heel with the sloping top surface to take care of ice pressure. This was added to the main section upon the recommendation of J. R. Freeman, the reason being that "there will probably be a crack form opposite the level of the crest of the bedrock due to difference of temperatures and shrinkage."

Reinforcing steel was added to the first and central sections, 9 in. from the heel face, to take care of ice pressure. This was calculated as assuming a maximum horizontal thrust of 40,000 lb. per linear foot at El. 4155. Ice conditions are always an anxiety for hydroelectric plants in such latitudes, and precautions must be taken to eliminate the troubles caused by them.

The foundation upon which the whole of these sections and part of the last section was placed is a very hard quartzose sandstone in strata from 1 to 3 ft. thick, loosely adherent to one another, and with softer shales intervening between groups of sandstone strata. The stratification inclines downward, upstream at an angle of about 20 deg., and the strike is almost at right angles to the main line of the stream. Sandstone covers the stream bed at the toe of the dam, except for 100 ft. at the west end of the end section, where there is soft shale. This was protected against scour with a reinforced-concrete blanket tied into the main dam. The sandstone strata have many small cross joints and the seams to the adjacent strata are not tight. These conditions necessitated the grouting of the foundations.



TEMPORARY SLUICE LEFT IN DAM DURING CONSTRUCTION WAS LATER FILLED IN

TUNNELS IN THE CENTRAL SECTION

For observation purposes two tunnels were placed in this central section—one in the main body allowing observation of any percolation through the dam—and with 2-in. pipe carried to the foundation rock every 10 ft. so as to free any uplift due to percolation underneath. This tunnel also has running into it at the upstream springing line 1 x 18-in. spaces, inclined upstream and carried close to the crest of the dam, to intercept percolation and bring it away before it reaches the ogee and causes scaling of the concrete through frost. These openings were placed every 16 ft., but it was later found by the writer, through examination at the dam of the plant at Horseshoe Falls, that they would have given even better service if spaced at 10-ft. centers.

The second tunnel was located below the rock ledge, and observation spaces 2 ft. wide were carried to the ledge from this tunnel at the more dangerous points, which gives an opportunity to watch any seepage through the rock seams, and a chance to grout the seams, should the seepage become serious. The two tunnels were connected in the central block at the end of the second section, where an outlet was also made to the one lower side of the dam. Communication to the tunnels is afforded by a shaft from the deck.

NO HEEL TRENCH USED

No heel trench was used in either the first or second sections. The danger of cutting through a stratum of sandstone is apparent. Two rows of 1¾-in. anchor bolts staggered 4 ft. apart, extending 3 ft. into both the rock and the concrete, were used.

The third section runs upstream, making an angle of 30 deg. with the central section to avoid a fall of 4 ft. in the river, and the consequent washed-out pool below it. It is 268 ft. in length between abutments, and is provided with eleven 18-ft. openings with 7-ft. intermediate piers. These openings are controlled with stoplogs. The sill is at El. 4138.

A tunnel runs through this section and will ultimately be carried into the rock of the abutment, should there be any sign of leakage making a way around the end. A retaining wall is carried beyond the spillway section, which also acts as a cut-off wall. From the tunnel 3-in. pipe is carried to the foundation rock every 10 ft. to relieve uplift pressure, and, later, holes were drilled through these pipes into the rock for an average distance of 25 ft. so that any percolation under pressure might be brought into the tunnel, and the pressure relieved. These "escape valves" are doing their work extremely well. There is a continual flow from many of them.

Expansion joints are allowed for in all sections at a distance apart of approximately 50 ft. Three-inch plank with beveled edges for convenience in removing were used to form checks, which were not continuous, but staggered. The expansion joints were not carried in a vertical plane, but broken back 3 in. and then out again 3 in. at a point 14 ft. above. The joint was coated with one layer of pitch and, because of the nature of the rock formation, it was deemed advisable to pressure-grout the foundations.

At the end of December, 1912, with some grouting still to be done, the total leakage through the dam was estimated to be about 50 gal. per minute, of which probably 20 gal. came from a spring in the center of the sluiceway section that was piped to the apron to give it relief. At the time of writing the leakage is almost negligible.

(To be concluded)

OXY-ACETYLENE WELDING FOR A WATER-PIPE OFFSET proved to be not only cheaper and a time saver, but also much neater in appearance when compared with ordinary pipe-fitting connections, in running branches from a 6-in. water main of the sprinkler system in the Indianapolis plant of the Presto-O-Lite Company, Inc. Because the main had been hung too close to the ceiling, it was found necessary to make offsets on one side 7¼ in. and on the other 5¼ in. to pass girders and other piping. On one side the standard fittings were used with a 45-deg. elbow giving a 12-in. drop. On the other side a short section of pipe, with ends cut at the proper angles, was welded into the line at a total cost of $3.40, as compared with a total cost of $17.50 for the standard fittings.

Sheet Piling a Remedy for Soft Spots in Wet Cuts

Concrete Side Walls Still Cheaper—Either Should Be Effective, and Less Expensive Than Concrete Slabs Under Track

By E. L. SINCLAIR
Assistant Engineer, Chicago, Milwaukee & St. Paul, Railway, Chicago

REFERRING to J. T. Bowser's article "Concrete Eliminates Soft Spots in Railway Roadbed" in the Engineering Record of Oct. 23, 1915, page 506, I submit herewith a sketch, Fig. 1, showing sheet piling along both sides of track which has been used successfully in just the kind of spots referred to by Mr. Bowser; that is, soft spots in cuts where the track settles badly for the length of a rail or two. Two rows of 3 x 6-in. x 8-ft. fir were used and were driven with a track driver, the ballast being first removed and a small trench dug to start the sheet piling in.

In July, this year, I examined a number of places where the sheet piling was driven in 1909, and in every case I found that the sheet piling had not pushed out of line, and the section foremen reported that they had had no trouble to maintain track since the sheet piling was driven. Before this, water stood in the bottom of the ballast in wet weather, and as it could not be drained out, the churning action of passing trains worked the clay next to the ballast into a semi-fluid state, and it was forced upward in very thin layers along the outside of the ballast, filling the cut ditches and causing the track to settle constantly. Since the sheet piling was driven it has been impossible for the clay to push out from under the ballast, and the settlement stopped in a short time after the piling was placed.

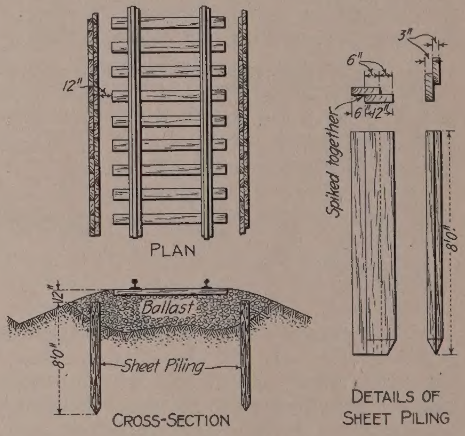


FIG. 1—SHEET PILING OF THIS TYPE HAS PROVED SUCCESSFUL

CONCRETE WALLS

I seen no reason why concrete walls, as shown in Fig. 2, would not serve the purpose fully as well as the sheet piling, and at less cost. While Mr. Bowser does not give the cost of placing concrete under the track, it must be much more expensive than it would be to dig trenches with a tile spade parallel with the track and fill them with concrete. In either case, it would be necessary to do the work in dry weather after the subgrade had dried out thoroughly.

Costs will vary greatly in different parts of the country, and if second-hand material is available for sheet piling the cost will be greatly reduced. For purposes of com-

COST OF 100 FT. OF SHEET PILING, BOTH SIDES OF TRACK	
9600 ft. b.m. 3 x 12-in. x 8-ft. piling at $25	$240.00
300 lb. 40d spikes at $2.50	7.50
Driving	60.00
	$307.50

parison, however, I submit the accompanying tables. They show that the cost of

COST OF TWO CONCRETE WALLS 8 IN. X 4 FT. X 100 FT.	
20 cu. yd. gravel, at $1	$20.00
140 sacks cement, at 0.35	49.00
595 lb reinforcing, at 0.02	11.90
Labor	50.00
	$130.90

sheet piling is about $3 per linear foot of track and that of the concrete walls about $1.30 per linear foot.

FARM DRAIN TILE USELESS

I am a firm believer in drainage, but am convinced that ordinary farm drain tile placed below the bottom of the cut ditch parallel to the track in a soft cut is money wasted in many cases. Unless the soil is porous, the water in the bottom of the ballast does not reach the tile, and the working of the subgrade will separate the tile at the joints, so that it will be found that no water flows from the tile after it has been in service for a year or two. The cost of 6-in. bell-end vitrified sewer pipe is about twice that of ordinary drain tile, but I would recommend its use, and if the subgrade is unstable, the tile should be supported and kept in line by a plank trough, as shown in Fig. 3.

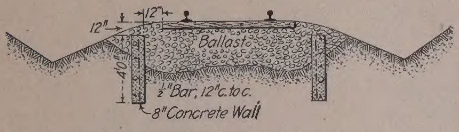


FIG. 2—CONCRETE SIDE WALLS SHOULD BE CHEAP AND EFFECTIVE

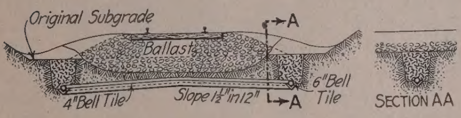


FIG. 3—DRAIN PIPE IN UNSTABLE SOIL SHOULD BE SUPPORTED BY PLANK TROUGHS

THE PRICE of "Elasticity and Resistance of the Materials of Construction," by William H. Burr, has been changed from $6.50, as stated in the review on page 24 of the issue of Jan. 1, to $5.50 net.

2500-Ton Concrete Cribs Are Built and Launched in a "Shipyard"

Combined Casting Yard and Marine Railway at Victoria Handles Heavy Cribs for Government Piers—Work Progresses Simultaneously on Five Cribs

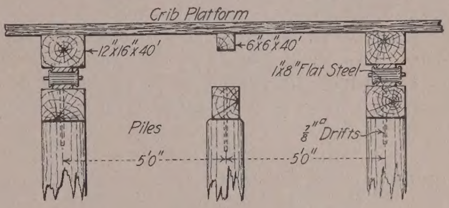
THE QUESTION of how to launch the heavy concrete cribs for the Government piers at Victoria, B. C., has presented new problems in requiring some method which could safely handle the great weights without interfering with the steady and speedy progress of the work nor exceeding the reasonable cost limit. The first scheme, using a large floating drydock on which two cribs could be cast and launched simultaneously, resulted in failure and was abandoned. An account of the accident that occurred when the first cribs were launched appeared in the Engineering Record of Feb. 20, 1915, page 247. Since then an entirely new plan has been evolved and used successfully which permits of the simultaneous construction of five cribs on a solid structure, and provides for launching on marine ways by slow stages so that there are never sudden excessive strains to endanger cribs or structure.

The general scheme of constructing the new government piers, which was explained in detail in the Engineering Record of Aug. 7, 1915, page 165, requires the construction of fifty-three concrete cribs, for the most part 80 x 35 ft. in plan, 39 ft. high and weighing about 2500 tons each. The first two of these cribs, constructed on the drydock, were found to be intact after the accident that occurred at the launching, and were later towed to the pier site and properly placed. The marine-way scheme for handling the cribs was then adopted and the first crib launched from the ways on Sept. 25. This was followed by another on Sept. 30 and still another on Oct. 8, all of which were launched without the slightest hitch. With the plant well under way and in regular running order it is expected that it will be possible to launch a crib every seven days.

BUILDING THE "SHIPYARD"

Each of the cribs, when floating, draws 27 ft. of water, and in order to secure the necessary depth of water in a place well sheltered from storms, it was found best to construct the plant entirely on pile foundations. The most favorable location was in Esquimalt Harbor, about six miles from the pier site. At this point the water is about 40 ft. deep at high tide and the bottom is mud and clay to a depth of from 45 to 60 ft., at which level bedrock is found. Construction of the plant was started here in February, 1915.

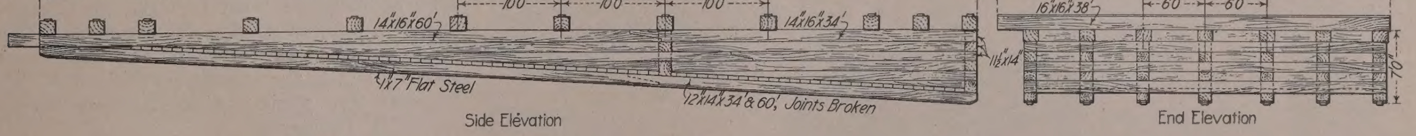
In order to have room for the simultaneous construction of five cribs it was decided to construct a skeleton wharf 90 x 225 ft. in plan. This wharf consisted principally of twelve parallel rows of piling capped with 12 x 16-in. timbers. The rows were spaced 10 ft. apart, except the two outer rows, which were on 4-ft. 9-in. centers. The piling in each of these rows was driven on approximately 2½-ft. centers. Only large Douglas-fir piles with the bark on were driven, and the average length exceeded 100 ft. Under the wharf a strong cross and sway bracing of 3 x 10-in. plank was used. On each of the 12 x 16-in. caps in this skeleton wharf a track of 1 x 8-in. iron was placed and held in position by ⅝-in. countersunk driftbolts.



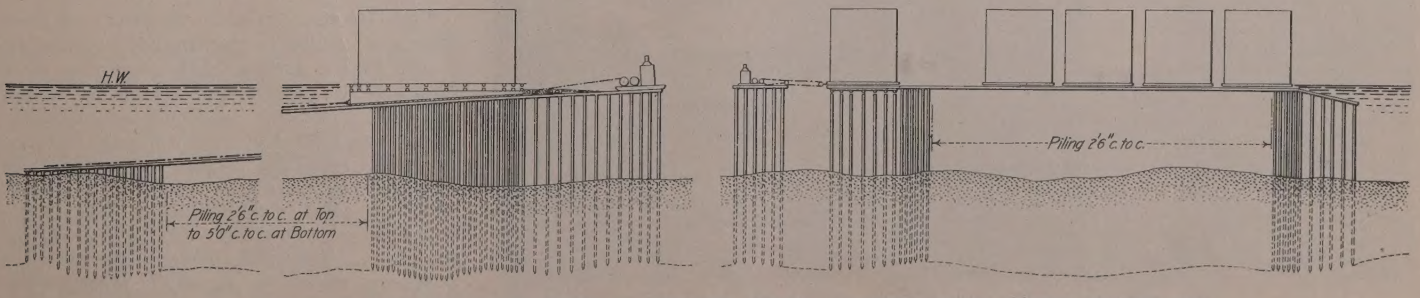
DETAILS OF THE CRIB PLATFORM

Five construction platforms 40 x 100 ft. in plan were built with parallel bottom timbers spaced the same as the caps of the skeleton wharf. The platform timbers thus furnished a bed for 1 x 8-in. iron tracks, which corresponded with the tracks on the skeleton wharf over which they moved on twelve rows of cast-iron rollers. These rollers are 4 in. in diameter and have flanges on each end to fit over the 8-in. iron tracks, as shown in one of the accompanying drawings. They are spaced on 10-in. centers and held in position in wooden frames in nests of ten rollers each.

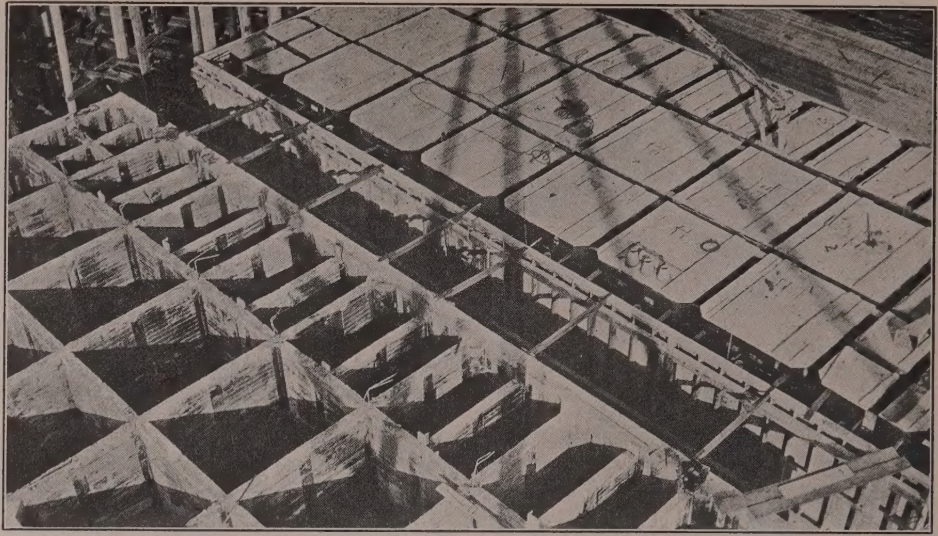
When the platforms are in position on the wharf the top planking is 6 in. above high water and the cribs are constructed directly on them. A layer of roofing felt is laid on the platform prior to the begin-



LAUNCHING CRADLE IS BUILT OF TIMBER AND FILLED WITH GRAVEL BALLAST TO OVERCOME ITS BUOYANCY



ENGINES CROSS HAUL CRIB AND PLATFORM ON SKELETON WHARF AND LOWER DOWN 700-FOOT MARINE WAY ning of work on each crib. This prevents the concrete from adhering to the platforms.



INSIDE FORMS AND REINFORCING STEEL OF CRIB IN POSITION

Marine Railway

The marine ways for launching the cribs is at one end of the skeleton wharf and at right angles to it. The track is 700 ft. long and has a grade of 1 in 18. It consists principally of seven rows of timbers constructed on piling, tied together with cross timbers and carefully braced. Additional support is furnished by batter piles placed along the outer piling of the structure proper. The piles in the incline are all selected Douglas fir and are driven on $2\frac{1}{2}$-ft. centers at the top of the track. They are gradually spaced wider apart toward the lower end of the track, where the buoyancy of the water reduces the weight of the crib. The piles were cut off under water on the required batter by a specially designed circular saw operated from the surface.

A 7-in. iron track for rollers is placed on top of each of the seven lines of timber. It is 1 in. thick at the upper end and gradually reduces to $\frac{5}{8}$ in. at the bottom. The track is spiked to the timbers with $\frac{7}{8}$-in. driftbolts.

The launching cradle is built of timber as shown in one of the drawings and is filled with gravel ballast to overcome its buoyancy. It moves up and down the incline on seven rows of 4-in. rollers with spacings varying from 10 in. between centers at the upper end of the track to 14 in. between centers at the lower end, where the buoyancy of the water lessens the weight of the crib. These rollers are held in position in wooden frames coupled together in each of the seven rows. The 16 x 16-in. cross timbers on the top of the cradle are spaced to coincide with the twelve-track timbers of the skeleton wharf, thus allowing the iron tracks on cradle and wharf to connect, so it is possible to roll the successive construction platforms with their respective cribs direct from skeleton wharf to cradle.

This cross hauling of the platform and crib to the cradle is accomplished by means of two sets of six-sheave blocks with $\frac{3}{4}$-in. wire rope, power being furnished by two 7 x 10 hoisting engines. The cradle is held rigid during this time by four 1 x 8-in. steel straps, which are released as soon as the crib is on the cradle, so as to allow the latter to move down the incline.

The rigging for lowering the cradle consists of two 14-sheave tandem blocks, one of which is fastened to the front end of the cradle and the other to the engine bed timbers at the upper end of the launching track. These blocks are reeved with $\frac{3}{4}$-in. and $\frac{7}{8}$-in. wire rope in such a way that the $\frac{7}{8}$-in. rope is in play during the heaviest pull and the $\frac{3}{4}$-in. rope comes into use as the buoyancy and resistance of the water decrease the load. A two-drum highly-geared 10 x 12 hoisting engine is used for lowering the cradle.

Owing to the resistance of the water and the power required to overhaul the 14-sheave blocks, the weight of the crib is not sufficient to carry the cradle to the bottom of the incline. A 7 x 10 hoisting engine located alongside the lowering engine furnishes the additional power required to do this. As soon as the first crib is launched, each remaining crib on the skeleton wharf is moved one space nearer by means of the same rigging used to move the completed crib from the wharf to the cradle. The empty platform taken from the crib at the time of launching is towed to the far end of the skeleton wharf and pulled up on the track by means of a short incline. It is then ready to receive the reinforcing steel and forms for another crib.

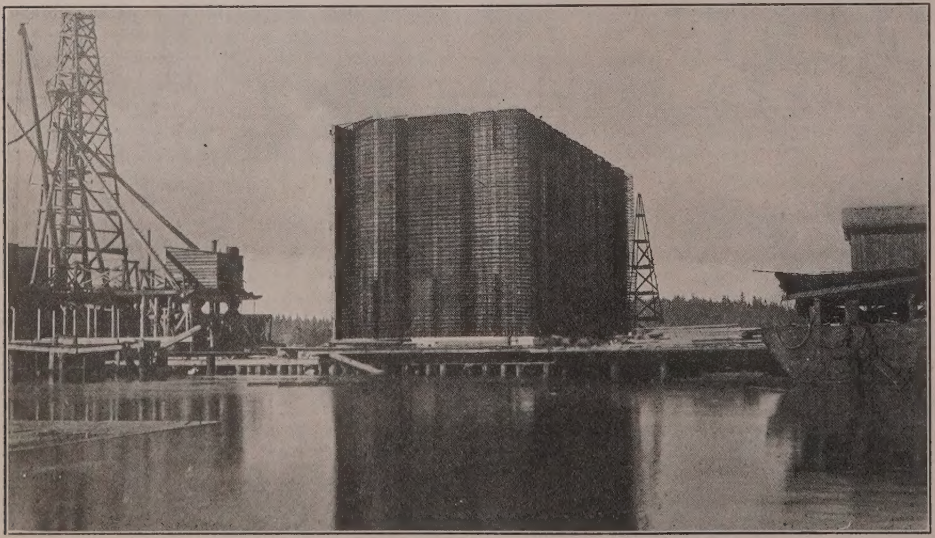
Concrete Plant

The mixing plant consists of a 1-cu-yd. Smith mixer installed on one end of a 1200-ton scow. Hoppers for sand and gravel were built on the deck to accommodate about 500 cu. yd. of material and were arranged to feed by gravity into measuring hoppers. A 30-in. conveyor belt running underneath the measuring hoppers conveys the sand and gravel to an elevator belt, which carries it to the charging hoppers. The cement is added in the charging hoppers and is handled by compressed air through a 4-in. hose from the cement shed.

The mixed concrete is deposited in the forms by the "open spouting" method, after being elevated 100 ft. in a tower on one end of the mixer scow. The sand and gravel is delivered from barges to the mixer scow by a derrick operating a $2\frac{1}{2}$-yd. clamshell bucket. The capacity of the plant is 50 cu. yd. per hour. The contractors operate their own hydraulic screening plant in furnishing the sand and gravel.

The numerous longitudinal and transverse bulkhead walls in each of the cribs made it necessary to adopt some type of collapsible inside forms for these bulkhead walls. The method in use and which is working successfully involves the use of sectional unit forms. Each section is so hinged together that when the inside braces are loosened and the form is subjected to a lifting pull, it automatically "collapses" and frees itself from the concrete. It is lifted out with a derrick and after the inside braces are replaced in position the form is again ready for use.

The "shipyard" has been constructed by Grant Smith & Company & McDonnell, Ltd., who have the contract for the two government piers now under construction. The design and construction of the plant was carried out under the supervision of H. W. Bassett, and plans and details were drawn by D. D. Updegraff.



FINISHED CRIB BESIDE ONE UNDER CONSTRUCTION ON WHARF

Two Hundred and Five Miles of new lines were added to the British railways in South Africa during 1914, according to a report of the general manager of the Union Railways quoted in the London *Economist*. The mileage of the four railways is now 3705 for Cape, 2436 for the Transvaal, 1180 for the Free State and 1164 for the Natal, making a total of 8485 miles. Part of the new mileage was a railroad built in record time from Prieska to Upington for military purposes, which is expected, however, to develop into an important commercial line.

Co-operation of Societies Needed to Secure Equitable Specifications and Contracts

Says President of Society of Engineering Contractors in St. Louis Address to Engineers' Club and Associated Engineering Societies

ENGINEERING societies and organizations of contractors can, it is admitted, do a great deal to cheapen the cost and improve the quality of construction and to decrease the uncertainties of contract work by agreeing on standard and equitable forms of specifications and contracts. The need for such action was clearly brought out by Hillis F. Hackedorn, president of the American Society of Engineering Contractors, in addressing on Dec. 1 last the St. Louis Engineers' Club and Associated Engineering Societies. He pointed out that specifications on most contract work are now incomplete, carelessly drawn or badly enforced; that most contracts are inequitable; that the English practice of making the engineer instead of the contractor responsible for the correctness of estimated quantities is much superior to our own; that arbitration by true third parties should replace arbitration by engineers, and that great advantage both to architects and builders has followed in the past three years joint action such as he advocates, which was taken by the National Association of Builders' Exchanges and the American Institute of Architects. Mr. Hackedorn said, in part:

There is one of our ideals which we of the present generation sincerely hope may be realized in all parts of the United States, and that is the ideal of equitable specifications and contracts; specifications that are written fully and completely describing the work down to the minutest detail, eliminating all guesswork and conveying to the contractor completely the ideas of the engineer. One of the greatest impositions that is ever placed on a contractor is caused by the engineer whose specifications fairly teem with the expression "to the satisfaction of the engineer." This much-abused, impossible-to-forecast expression is about as serious a handicap as can be hung on a contractor who is making up an estimate of cost for any type of construction. It leaves too wide a field for guesswork and opens up too broad an avenue of opportunity for the engineer or the inspector to "get even" with the contractor for some fancied or real grievance. It is something against which a contractor has no opportunity whatever to protect himself. I have seen contractors practically ruined in an effort to satisfy an engineer who was unreasonable, but who nevertheless was backed by brass-bound specifications containing this damnable clause. The phrase impresses the contractor as an evidence of either lack of knowledge on the part of the engineer or laziness in preparing the specifications.

ENGLISH PRACTICE GOOD

In Great Britain carefully prepared schedules as to quantities are submitted to the contractor. These quantities are guaranteed, and in case of error the contractor has a ground of action against the quantity surveyor. This method enables the contractor to estimate the cost of work much more closely than can be done in this country, where all estimates of quantities are frankly labeled as guesses, and the engineer dodges all responsibility by stating that the contractor must assume all the hazard as to errors in such estimates. Of course under these conditions the contractor must charge for an element of chance which should not enter into the proposition. The engineer should make his estimates carefully and thoroughly and be ready to stand behind them in case of error. I know of but one bridge engineer who guarantees his quantity estimates. As a result, bidders can make much closer estimates on this man's work, knowing as they do that he will stand responsible for any errors in his quantity statements.

An unfair engineering practice frequently resorted to in the writing of specifications is to require the contractor to prepare the detailed working drawings for a job, including, for reinforced concrete, bending diagrams and special details as to connections of reinforcement. This makes it necessary for the contractor to maintain a much more expensive engineering and drafting department than would otherwise be required. In addition to this, some specifications require that the contractor, "having checked the plans, shall be responsible for the correctness of all drawings as to dimensions, elevations and corelation of the various parts," thus making the contractor absolutely responsible for the correctness of the engineer's design and drawings, and throwing on him in case of error the expense of correction. The contractor is given no extra allowance for preparing his drawings, but must do it at his own expense and deduct it from his estimated profits, when it should be taken from the engineer's fee. Many engineers even require that the contractor shall furnish several sets of cloth-mounted drawings, and as many sets of paper blueprint copies as the purchaser and engineer may desire. This might result in an almost unlimited abuse, and while it is a small item on a large job, it is one of the mice that eat away the substance of the contractor's estimated profit.

GIVE BIDDERS COMPLETE PLANS

Our position in the matter of detailed specifications is that we know of no legitimate reason why the contractor should not have full detailed information as to what will be required in the execution of a given contract before the contract is signed. He should not be required to make haphazard guesses on small-scale drawings and indefinite specifications frequently lacking in vital information. If detail drawings have not been completed before the date on which bids are requested, the date should be postponed to give the engineer an opportunity to prepare complete working drawings. It takes no longer to study the details of a structure before the contract is executed than after. A careful preparation of detailed drawings and the writing of complete specifications will result in a saving of cost to the owner, because when this is not done the contractor has to add a certain per cent to cover the uncertainties of the contract.

It has been our experience that where the engineer co-operates with the contractor the quality of work is very much improved, resulting in a great benefit to the owner. Of course if the contractor knows that the engineer is disposed to treat him fairly and not impose unnecessary hardships on him, he will in return for this confidence exert every effort to give the owner the benefit of his experience in producing the highest class of results.

The classification of excavated materials is one that has probably caused as many controversies as any other single item in an engineer's specifications. This point should be fully covered in all specifications so as to eliminate entirely the necessity for guessing at information which the engineer himself might supply. It would be far better for the owner if some preliminary money were spent more frequently in test pits and borings to ascertain the character of the soil to be encountered in excavation.

One of the most dangerous conditions in the great majority of specifications is the clause providing that the engineer shall be the final judge of the interpretation of the specifications. The lawyer would call this ex parte, for the reason that the engineer is in the employ of the owner and his judgment is bound to be biased toward that side. Of course I realize that the engineering profession takes the high and lofty position that the engineer's judgment will be fair to both contractor and owner; that he, like Caesar's wife, is above reproach, and that the contractor should have faith enough in him to believe that the engineer will give him a square deal. Investigation and inquiry among hundreds of contractors has convinced me that this presumed fairness and equity on the part of the engineer is the exception and not the rule.

CHANGING PLANS UNFAIRLY

One manifestly unfair condition in many specifications is that giving the engineers the right to make minor changes in the plans without extra compensation to the contractor, unless, "in the opinion of the engineer," he is entitled to such extra compensation, the amount of which is to be determined solely by the engineer. This condition leaves a very large opening for the engineer to abuse his authority over a contractor whom he does not like, or to seriously cripple him when, in the opinion of the engineer, the wrong man has landed the job.

One of the ideals of the American Society of Engineering Contractors is that the specifications should provide in the event of any disagreement between the contractor and the engineer that such question shall be submitted to arbitration, the engineer and the owner on one side and the contractor on the other being bound beyond appeal to the decision of the arbitrators. In our opinion this removes the danger of the contractor's being injured by the decision of the engineer, or of the owner's being defrauded by unfair work of the contractor. It would mean the elimination of controversies between the engineer and contractor.

One of the greatest injustices, to my mind, and one which enters into nearly all of the specifications, is the clause requiring the contractor to assume the responsibility for the infringement of any patent used in the performance of the contract. The engineer prepares his design, specifies his materials and method of construction and puts the responsibility on the contractor for ascertaining whether or not there are any patents on the type of design or materials used or on the method of construction. It seems to me that this is part of the duty of the engineer and that in making his design he should ascertain beyond the possibility of a doubt whether or not it infringes any of the many patents which have been granted. In case he cannot make a design without infringing a patent, either he should notify all bidders of the existence of the patent, and the fact that his design infringes, or he should obtain from the owner of the patent the right to use it for a specific price on the work.

ENGINEER SHOULD NOT RUN THE JOB

Another inequity is that giving the engineer the right to direct the sequence of the work and issue orders as to the manner and time in which the various parts of the work shall be done, and the force required to complete it within the time specified. I believe that I can state without fear of contradiction that no two contractors would handle the same job in the same manner and sequence. It is customary in making up estimates to plan carefully the manner and sequence of the construction. If the contractor is not permitted to follow his own methods it frequently results in turning a contract that would otherwise be profitable into one that shows a loss. The contractor is the man who pays the bills, who furnishes the surety bond guaranteeing the construction according to the plans and specifications and in a given time, and, in my opinion, he should not be hindered by the ideas of the engineer.

CUTTING ESTIMATES ON PRINCIPLE

Another practice followed by some engineers is the pruning of monthly estimates for payment. As a general proposition the engineer or inspector directly in charge of a job, who is frequently a young man, will make a decided practice of underestimating work actually done. As a result, after taking off the percentage held back as provided by the contract, a contractor is paid in reality 50 or 60 per cent of the work actually done, where he should get 80 or 90 per cent. Of course this has no bearing on the engineer's ability, but it frequently embarrasses the contractor in financing big jobs. An important point in the preparation of estimates for pay, in which I believe contractors will bear me out, is that engineers should make an allowance for material on the ground ready to be worked up, a sum covering forms and preliminary work, and in some instances a sum approximating the cost of new equipment that is bought to handle the special job. Of course I realize that the engineer will say that many contractors will be unreasonable in these plans. If, however, engineers will show a disposition to help the contractor along these lines, I believe that 90 per cent of the contractors would be disposed to strain points in favor of the engineer and owner, and give them a higher type of construction. It would be nothing more than an appreciation of a favor extended, and along this line we are all human and willing to show our appreciation of any such help.

CONTRACTORS BLAMED FOR ENGINEERING ERRORS

The business relations between the contractor and engineer are little understood by the public at large. We frequently hear a contractor on public works condemned for failures in bridges, roads or pavements when he was entirely innocent, having built the work in strict accordance with the specifications furnished. Yet the general public makes him the goat, and the engineer, who has prepared faulty specifications, goes scot free. Of course the engineer may take the high position that if the contractor does not like his specifications he need not bid on the work. This is not only unfair to the contractor, but also to the owner, because it reduces competition by eliminating intelligent and responsible contractors. Some contractors go so far as to refuse to bid on work where the specifications are not fair and completely detailed; but where a contractor has a large organization with a certain amount of overhead expense, he is of course anxious to make as good a showing on the capital invested as he can. If he were to pass up unfair specifications he would lose many pieces of work which he could do at a profit under fair specifications.

A prominent engineer in a paper recently read refers to the personality of the engineer as probably the most important factor in the relations between engineer and contractor, stating that some engineers have a notoriously bad name and do not appreciate the responsibility of the honorable position they occupy. The wise engineer knows that many contract conditions can be ignored without any harm being done, and that many facilities can be given the contractor to expedite the work. We believe that contractors as a body will not take unfair advantage of these concessions, but will in their turn go out of their way to meet some special request of the engineer, playing the game of give and take in a reasonable way without expecting extra pay for every trifling piece of work.

WORK OF BUILDERS' EXCHANGE A MODEL

The National Association of Builders' Exchanges, of which H. L. Lewman of Louisville, Ky., is president, has been working for a number of years in conjunction with the American Institute of Architects to secure standard specifications and contracts for the use of builders. How well they have accomplished this work is evidenced by "The Standard Documents of the American Institute of Architects in collaboration with the National Association of Builders' Exchanges." These documents define the duties, scope and power of the architect, the duty of the contractor, the scope and limit of arbitration, and the rights of subcontractors. The specifications and contract forms have been so carefully prepared and revised that it is difficult to find any point wherein there can be criticism. Their theory is to insist upon the use of the principle of arbitration on every possible question that can be settled without resort to the courts. But the greatest lesson to be derived from the joint work of these two national organizations is the accomplishment of beneficial and just results by means of joint organization, co-operation and close affiliation. As a consequence of this work the membership of the National Association of Builders' Exchanges more than doubled during the year 1913, again doubled in 1914, and has almost doubled again in 1915. If it were possible to bring about such close relations between the various national engineering societies and all of the national contractors' organizations the result would be beneficial to all engineers and contractors, and losses caused by misunderstandings of contracts and specifications would be almost entirely eliminated. Such uniform action could bring about the adoption of standard specifications and contracts based upon equity, intelligence and fair dealing, ever guarded by the idea of arbitration.

Admits That Market Value Will Not Reproduce Land

California Commission Concedes Need of Multiples to Get Cost to Reproduce, but Says Reproduction Cost Is Not Cost to Reproduce

VIRTUAL admission by the Railroad Commission of California that multiples in some form or other are necessary for determining the true cost to reproduce land is found in the commission's report, dated Dec. 8, 1915, in the matter of the valuation of a part of the Central Pacific Railway. The commission takes the stand, however, that the Minnesota rate decision necessitates the use of a different figure, "market value," in an estimate of reproduction cost.

The case is not one brought to settle a definite point in dispute, but is an investigation on the commission's own initiative to determine original cost, reproduction cost and reproduction cost less depreciation. The commission defines "reproduction cost" as follows, the italics being those of the Engineering Record:

"The term 'reproduction cost' means the estimated *cost* in cash of reproducing, in the condition (new or second-hand) in which it was acquired, the *physical property* of the public utility in the State of California, as of the date of valuation; to which is added the *value* of all operative *lands*, based on the market value of adjacent and similar lands, the actual or estimated *cost* of acquiring franchises and the estimated *cost* of overhead expenditures for engineering, law, interest and similar items."

This combination of cost and value to get a cost figure the commission justifies, as previously stated, by the familiar passage from the Minnesota rate decision. According to the commission, the U. S. Supreme Court "disapproves of the 'cost to reproduce' theory of fixing right-of-way valuations," even in estimating reproduction cost.

In the case in question the commission finds these three figures for the land: Original cost, $31,540.53; reproduction cost, including interest, $34,959.54; market value (which is the figure used by the commission in its final estimate of the reproduction cost of the whole property), $20,717. The commission does not discuss the moral side of the allowing of only two-thirds of what the land actually cost, as compared with a figure but 10 per cent in excess of the actual cost.

A METHOD FOR ACCELERATING the hardening of concrete, in order that the material might be used instead of willow mats in Mississippi River revetment work, has been the objective of experiments made by the U. S. Bureau of Standards. The bureau finds that 4 per cent of calcium chloride added to the mixing water increases the strength of the concrete at the age of one day 100 per cent or more. In some cases the strength of the concrete in which the calcium chloride was used at the age of two days equaled 75 per cent or more of the strength normally attained in one month.

Tunnel Drill Carriages—Their Economic Possibilities

Second of a Series of Three Articles Dealing with Heading Work at Mount Royal Tunnel and Showing How Best Features of Several Machines Could Be Used to Produce Ideal Drill Carriage

By S. P. BROWN
Chief Engineer, Mount Royal Tunnel & Terminal Company, Limited, Montreal

[In the first article of this series, published last week, Mr. Brown discussed the general features of American and European drill carriages, differentiating the several types of equipment and describing the developments which have been made from the simplest machine, without overhang, to the latest device with cantilever arm and muck-handling conveyor. This week's article, Part 2, deals with the Mount Royal tunnel heading work and carriages, and presents a summary of the essential points in heading drill carrying design.

Certain illustrations used in Part 1 are referred to in Part 2. These have been repeated so as to bring text and illustrations together, thus allowing the reader to gain a clear understanding of the subject without having to refer back to last week's issue to identify pictures and drawings.—EDITOR.]

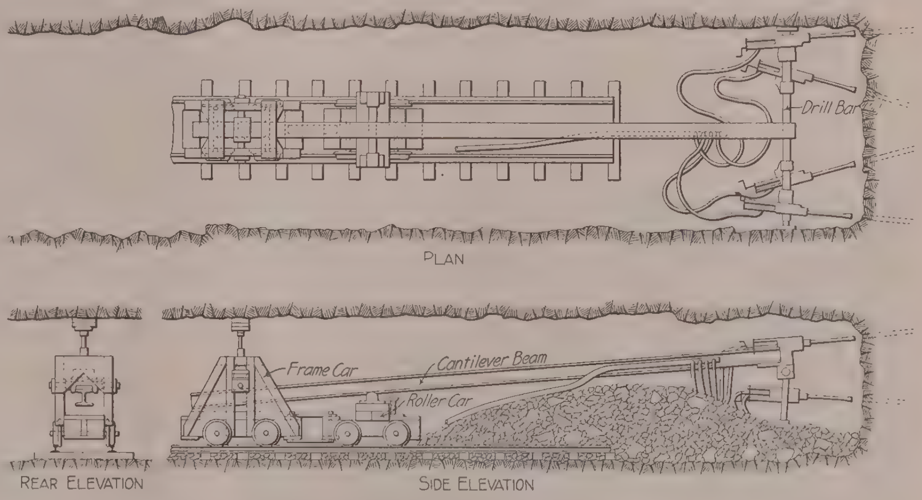
IN the Mount Royal tunnel the ordinary method of heading excavation was by means of a horizontal bar mounting four drills. The drills were supported on arms similar to those used on the columns common to American tunneling operations, or on special saddle arms particularly designed for this job. Sullivan reciprocating, or percussive, drills were used, so constructed that where the ground made it economically desirable a jet of water and air could be injected through the pistons and steel into the bottom of the holes being drilled. For this reason hollow steel was generally used. (See double hose connections in Fig. 10.)

HEADING WITHOUT DRILL CARRIAGE

Before the rock in the heading became so hard as to require very heavy drills, no drill carriage was used, the drilling equipment being carried and erected by hand (Fig. 10). By this method in Trenton Limestone, before the rack had become too crystalline, the maximum progress of 810 ft. was made in an 8 x 12-ft. heading in 31 working days, a record-breaking performance. Six rounds were drilled and fired each day, two each shift. The maximum day's progress was something over 30 ft., while on days when igneous dikes of importance were encountered the progress would sometimes drop below 20 ft., and occasionally a shot would be lost.

Seven muckers were used to handle this excavation, three casting back from the face and four shoveling into the cars. All mucking was done off slick sheets and the cars were designed especially low. Thus the four muckers shoveling into the car handled all the muck made on their shift, which amounted to from 12 to 15 cu. yd. per man per shift. This record is particularly interesting when it is remembered that nearly 2 hours out of each 8-hour shift were lost in blasting.

To break this rock required from 18 to 22 holes and about 500 steels per day for an advance of 26 ft. Four 2⅝-in. Sullivan water drills were used, with the water emulsion through the steel. Each driller averaged about 12.5 ft. per hour, deducting only the time lost in blasting. About 6.8 ft. of hole were drilled per cubic yard of place measurement and about 5.5 lb. of 60 per cent Forcite powder were used per cubic yard with 30-grain detonators.

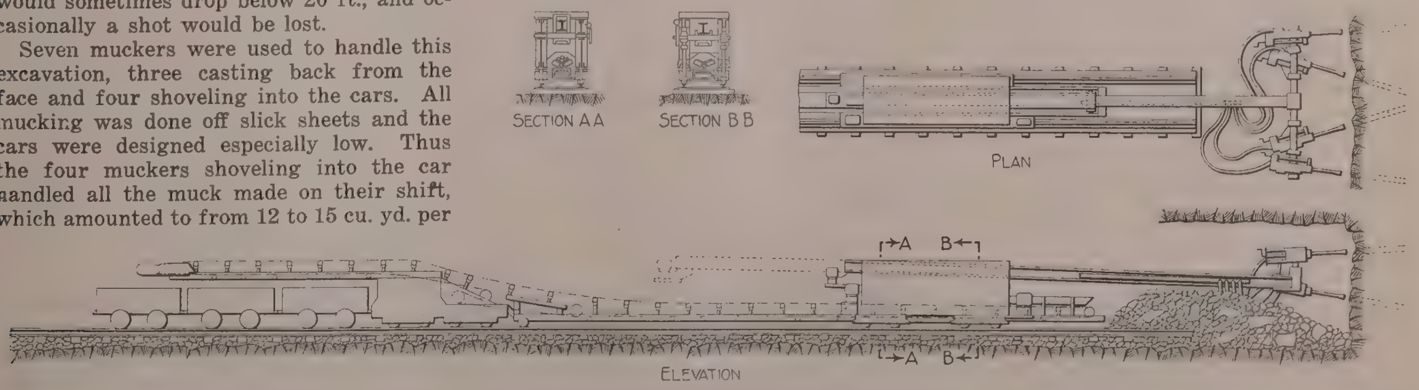


3.—IN SIMPLEST TYPE OF CARRIAGE A LONG ADJUSTABLE CANTILEVER ARM EXTENDS DRILLS ON HORIZONTAL BAR OVER MUCK PILE

HEADINGS WITH DRILL CARRIAGES

As the rock became harder and more complex, requiring more powerful drills, it became imperative to devise some mechanical means of handling the equipment, which had attained a weight of several tons. The common type of European drill carriage, already described in Part 1 and shown in Fig. 5, was not suitable in the present case. This was principally because the Mount Royal headings, averaging from 50 to 100 per cent larger than the Alpine tunnel headings, broke so much ground that time could not be spared to muck out the heading before setting up the drills. It was, therefore, necessary to devise a drill carriage with a long cantilever arm by which the drilling equipment could be extended ahead over the muck pile in the heading, without any material delay after the blasting was completed.

In order to bring the carriage near enough the face for an arm of reasonable dimensions to reach the point where the drills were to be set up the track on which the carriage ran was riveted to steel plates, which could act as slick sheets and could be mucked off rapidly, as described in Part 1. Thus, after the blasting, the muckers cleared this track to within about 25 ft. of the face by throwing the muck that had fallen on it to the sides. As soon as this was done the drill carriage was run in, hard up against the muck pile, the cantilever arm carrying the drill bar was extended, and the drill bar jacked into place. The drills were thus always in the heading by the time drillers had the roof and sides barred down and sufficient muck thrown back from the face to permit the drill bar to be set. While the drillers were jacking up the bar the pipe-fitter was connecting the

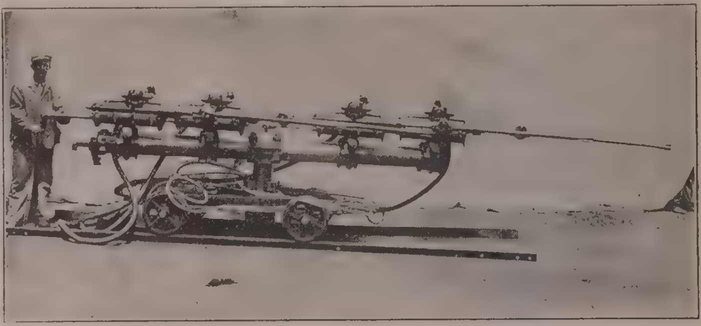


4.—A MORE COMPLICATED CARRIAGE PROVIDES FOR MECHANICAL OPERATION IN EXTENDING AND ADJUSTING BAR AND WAS EQUIPPED WITH MECHANICAL MUCKING DEVICE AND TRANSPORTER two large drill carriage hoses to the ends of the water and air pipes entering the heading. None of the drills was ever dismounted from the bar or disconnected from its manifold. The drillers started work as soon as the bar was tight.

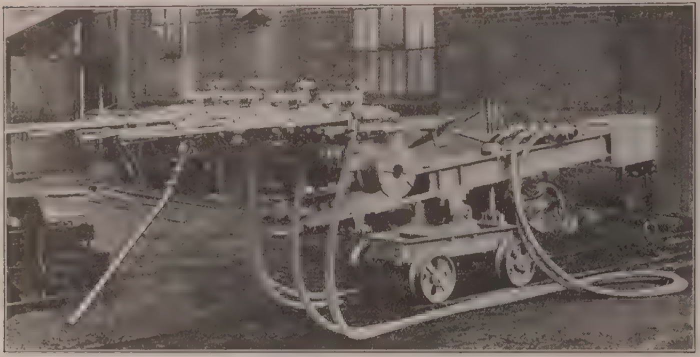
Two types of carriages were designed and built. One (Fig. 3) was very simple, for use in the small 8 x 12-ft. heading; it was merely a carriage proper somewhat similar to the Carter carriage (Fig. 8), described in Part 1, except that the cantilever beam moved with the drill bar instead of having the bar slide on the beam. The other (Fig. 4) had the moving beam, but as it was for use in the large heading, 10 x 13 to 14 ft., it also had a muck-handling attachment for transporting the excavated material from the face to cars in the rear.

DRILL CARRIAGE INCREASES PROGRESS

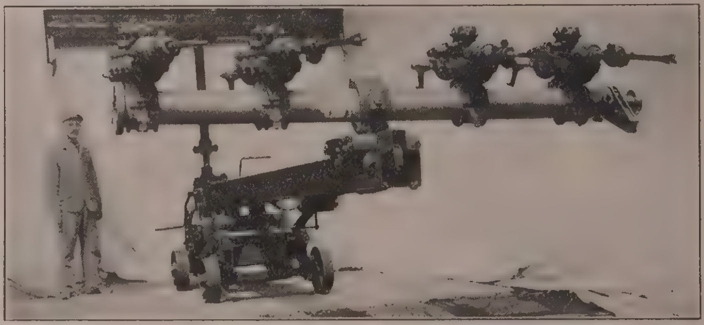
The effect of drill carriage work is shown by the results obtained, for instance, in heading 3 E where the muck-handling drill carriage operated for over six months. For the six months prior to the installation of the drill carriage in this heading the average progress was 350 ft. per month in crystalline limestone cut by numerous dikes and in places highly impregnated with various contact minerals. For the six months after the installation of the drill carriage the average progress was 485 ft. per month, almost entirely in Essexite. The hardness of the rock may be realized from the fact that 20 to 24 holes were required to break the ground and about 1000 steels were used a day for an advance of 19 ft.



7.—MOBILE CARRIAGE DESIGNED TO CORRECT CERTAIN FAULTS IN PREVIOUS TYPES OF APPARATUS



5.—OLD EUROPEAN CARRIAGE, WITHOUT OVERHANG, MERELY TRANSPORTS DRILLS TO WORKING FACE



8.—CARTER DRILL CARRIAGE, THE PIONEER DEVICE WITH ADJUSTMENT FOR EXTENDING DRILLS OVER MUCK PILE

SAVING EFFECTED

Four 3⅝-in. Sullivan drills were used. The water attachment was not used, as the length of time required to put down a hole caused the water to freeze and gave trouble in operation. Each driller averaged about 8 ft. per hour, deducting only the time lost in blasting. About 7 ft. of hole were drilled per cubic yard of place measurement, figuring the heading 9½ ft. high by 13 ft. wide. About 7 lb. of 60 per cent powder were used per cubic yard with 30-grain detonators. As the force employed with the drill carriage was practically the same as that employed without it the increase of 38 per cent was made at a considerable saving.

It is interesting to note that the progress made with the simple drill carriage was almost identical with that made with the muck-handling drill carriage, the former requiring slightly more muckers per cubic yard. Fig. 11 shows graphically the last few weeks of progress of both simple and muck-handling drill carriages. The abscissæ are distance by stations and the ordinates are time. The remarkable regularity of drill carriage progress is here shown quite clearly.

SIMPLE CARRIAGE

The simple drill carriage (Fig. 3) was a much lighter affair than the muck-handling one. A drill carriage was not required in this heading until the latter part of the run, when the very hard rock was encountered. The carriage had a 36-ft., 11 x 11-in. beam, which supported the horizontal drill bar and cantilevered out over the muck pile, as already described. At the forward end a special steel casting, similar to a pillow block, was attached to the beam with a vertical swivel so that the drill bar, which was clamped into the casting, might be swung about in a horizontal plane. Thus, when working, the bar was at approximately right angles to the beam and when being moved in and out of the heading, it was swung almost parallel with the beam to give ample clearance at the sides of the gangway.

The carriage consisted of two cars, each having four wheels brass-bushed to 4-in. axles. These axles were square and fitted into vertical slots in the platforms of the cars with bolts giving about 1 in. play vertically. This permitted the wheels and axles to play up and down in the slots and follow the local irregularities in the track, thus avoiding derailment in moving to and from the face. As the wheel base of each car was short no trouble was experienced from curves or switches.

The front car consisted of a platform of 12 x 12 in. maple, heavily cross-bolted. This body supported an 8-in. steel-faced roller over which the cantilever beam traveled. Just in front of the roller was a screw jack which cleared the track when in its lowest position, and was capable of raising the beam about 4½ ft. above the track when fully extended. Immediately behind the roller was a base for another jack, by which the beam could be further elevated when desired.

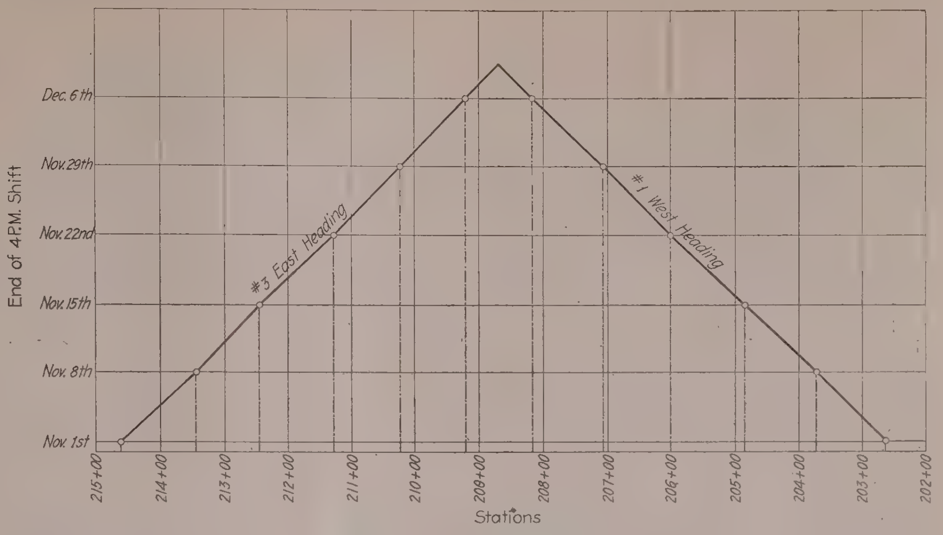
The rear or A-frame car consisted of a platform similar to the ones just described, with a steel plate and angle A-frame extending about 5 ft. 6 in. above the track. This A-frame had vertical guides at the sides, in which a horizontal roller, at right angles to the longitudinal center-line of the carriage, played up and down. This roller, under which the cantilever beam traveled, supported a babbitted saddle, which formed the bed for a screw jack that was placed between the roller saddle and the heading roof when the beam was being rammed ahead. The two cars were coupled together so as to give articulated travel in passing switches and curves.

When the carriage was moving out and in, the beam was slid back so that the weight of the drilling equipment was well overbalanced by the weight of the beam behind the forward roller. After the track had been mucked off to within about 25 ft. of the face, the carriage was pushed in by a locomotive until the front roller car was jammed hard up against the muck pile. Then the jack was set between the rear roller saddle and the heading roof and the beam rammed ahead, through the rollers, by the locomotive. Vertical adjustment was obtained by means of the roof jack. The lateral movement was usually small and could be obtained by the drillers swinging the forward end of the beam to right or left by hand. As the front roller was machined smooth and kept well greased no difficulty was experienced in sliding the beam from side to side as required. Fig. 12 shows the beam shoved ahead and the drill bar being set.

PREPARING FOR DRILLING

After the drill bar had been jacked into place a short, vertical jack leg was screwed tight between the bar, close to the beam connection and the muck pile underneath, to give additional support and rigidity. Next, the roof jack was removed and the carriage drawn back until the rear end of the beam would rise clear of the A-frame. Then the front vertical jack was extended and the beam raised, pivoting around the drill bar until it was close to the roof of the heading. When this was done a gallows frame was set up, consisting of two strong horses, one on each side of the gangway and a 6-in. pipe which spanned the gangway between the horses under the beam. This permitted the passage of muck cars and the usual mucking operations to go on as though no drill carriage had been used, the carriage itself having been hauled back to a siding out of the way. Fig. 13 shows the beam on the gallows frame and mucking in progress.

Although the muckers lost a few minutes during this operation, and only one central track was used at the face, no more muckers were required to clear out the heading with the drill carriage than were used before the drill carriage was installed. This was probably due to having the track cleared down the center of the heading, which permitted all the muckers to work to better advantage while the mucking was actually going on.



11.—REMARKABLE REGULARITY OF DRILL CARRIAGE PROGRESS SHOWN BY LAST FEW WEEKS' WORK WITH SIMPLE AND MUCK-HANDLING DEVICES

MUCK-HANDLING CARRIAGE

The muck-handling drill carriage, which was the first one to be actually built (Fig. 4), was a very heavy machine, having all of its parts operated mechanically, and was designed to remain in the heading while the drilling and mucking were going on. The conveying belt, 16 in. wide by 75 ft. between head and tail pulleys, was driven by a Dake air engine. All other power was electrical. The carriage consisted actually of two separate machines or carriages: First, the drill carriage proper, which supported and operated the cantilever arm carrying the drill bar; and, second, the muck conveyor, which slipped through the lower part of the drill carriage and was supported a few inches above the track on cross shafts. The belt was elevated in order to cantilever out over three muck cars in the rear.

Eight wheels were used on each car or carriage. Four-wheeled trucks, with through axles, could not be used on account of the low position of the belt conveyor. Special trucks were, therefore, designed, by which the two wheels on each side were held in a special steel casting with a king-pin to the frame above, thus giving the necessary flexibility for traveling over curves and switches. No springs were used, but the same effect was obtained, in regard to staying on the track, by having the brass axle boxes fitted to vertical guides, with about an inch play below them. Thus when local depressions in the track were encountered the wheel could drop down in its guide to follow the rail, as described in the simple carriage, and derailment was almost unheard of. Similar trucks were used on the conveyor car. The bodies of both cars or carriages were built of steel plate, heavily reinforced with angles, so that the frames could not warp or twist under the heavy strains to which they were subjected.

The cantilever arm was similar to that in the simple carriage. At the rear end of the cantilever arm an electric motor was attached, geared to a long threaded shaft running close to the web between the flanges of the I-beam. This threaded shaft screwed through a nut that was attached to the frame of the carriage, thus giving the beam its longitudinal motion. The beam was supported in saddles, with rollers to reduce the friction in its longitudinal motion. Fig. 14 shows the rear of the drill carriage proper with the beam extended.

The saddles supporting the beam were in turn supported on 5-in. threaded shafts at right angles to the longitudinal center line of the carriage. The threaded shafts were rotated in opposite directions by an electric motor at the rear end of the carriage to give the beam its lateral swing. The rear shaft, just described, was fixed in position, but the front one was so arranged that it could be raised and lowered in guides by means of large screw jacks running on ball bearings. These jacks were operated through worm and gear reductions by an electric motor on the front of the carriage, thus giving the beam its vertical swing.

ONE-MAN OPERATION

Thus it may be seen that when the tracks were cleared and the drill carriage run in, one man at the electric switches was able to extend the beam over the muck pile, raise or lower it, or swing it to right or left, as the case might be, to fit the heading as it happened to break. Although this machine appears at first glance to be cumbersome and complicated it is an interesting fact that breakdowns of any sort were very rare. In fact, during the six months of its operation the total delays in any way connected with the drill carriage did not aggregate one shift in lost time. Fig. 15 shows the drilling in progress with this carriage.

The principal advantages of the muck-handling drill carriage are these: As the carriage remains in the heading after the drills are set up the mass behind the drills is so great as to practically eliminate all vibration during the drilling. Its movements are mechanical, so that the setting up and taking down are more rapid. Since the muck is thrown off the track to the side, the carriage track being laid at one side of the gangway, the muckers can work with equal efficiency anywhere along the line. As the conveyor is very low, less exertion is required by the men than in shoveling into the higher cars. Three cars are run in at a time by the locomotive so that the muckers lose less time through the shifting of cars.

HEADING CARRIAGE CONCLUSIONS

In a heading where the section is large, or the rock reasonably soft, so that the

10.—DOUBLE HOSE CONNECTION TO RECIPROCATING DRILLS ON HORIZONTAL BAR ALLOWED USE OF AIR AND WATER JET THROUGH HOLLOW STEELS IN MOUNT ROYAL TUNNEL yardage to be handled each day is very considerable, the muck-handling drill carriage is far preferable to the simple carriage. This is especially so where the drilling is rapid, so that a good number of shots per day are obtained, since the time saved in setting up and taking down, as well as the rapidity of mucking, is an important factor. If, however, the rock is hard and the heading small the simple drill carriage will give just as good progress and for a reasonable amount of muck the cost per yard is just as low.

It is the writer's opinion, after having operated both machines under very similar conditions, that the simple carriage is superior to the heavier machine except where a large volume of muck has to be handled or inefficient muckers must be employed. This is principally on account of first cost, since that of the simple carriage is insignificant.

LIGHT VS. HEAVY DRILLS

The question of the permanency of the heading drill carriage in tunnel work depends mainly upon one thing—the rapid development and growing popularity of pneumatic hand drills. Should these be perfected and made thoroughly adaptable to heading excavation it is probable that the heavier and less convenient drill, either of the reciprocating or hammer type, will have to go. In this case the drill carriage would, of course, have no further use.

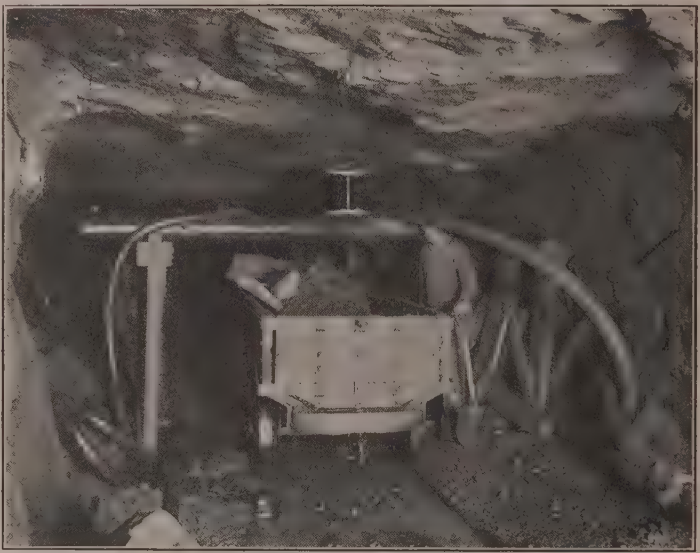
The writer believes that while the pneumatic hand drills are bound to become a very important factor in every tunnel work, outside of actual heading excavation, they will never replace the heavier machines at the heading face—at least until some decidedly radical changes are made in their design. He has used them in almost every combination possible in order to replace, as far as practical, the heavier type of drill. He has used almost every make in America, besides what he believes to be the best European drills. In stopes, break-ups and enlargements of all kinds these drills are excellent. In headings, however, where the space and available air supply are so limited and where a comparatively large number of drills must be operated simultaneously, they are not practicable. The dust becomes so dense that even with respirators it is only a little while before the men develop throat and lung trouble. There are various apparatus and methods for laying the dust as it blows out of the hole, but these, in the writer's experience, have either proved infeasible, inconvenient or inefficient. Where solid steel has been used much trouble has been experienced from the steel sticking in the hole. Where water is introduced through the steel with the air, the drill becomes awkward and changes in type.

MECHANICAL HANDLING AN ADVANTAGE

Regarding the general lightening of drilling equipment, both by improving the materials used in manufacture and by the more extensive use of the hammer drill, the writer does not believe the effect will reduce the popularity of the drill carriage methods. Although light drills greatly reduce the labor in taking down and setting up, as long as a drill is used that requires a substantial mounting it is almost axiomatic that an apparatus which will handle the entire equipment at one operation mechanically is not only quicker but far more economical in human energy.

In comparatively free drilling rock of low specific gravity, where very light drills may be used, it is sometimes possible to make exceptional spurts of speed without the aid of a drill carriage. Such efforts, however, take it out of the men and often have their reactions to the detriment of the general welfare of the job. Even with light equipment men who have carried it over the debris into a heading through the smoke and have had to assemble and erect it are already half worn out before the drilling actually commences. Had drill carriages been used in the Mount Royal tunnel from the beginning, a much higher average of speed, as well as greater economy, might have been attained. Although the writer realized this at the time, since the workmen had to be educated even in the use of the horizontal bar, he considered it unwise to make too many innovations, in the face of a very general doubt and opposition, until the first steps in the development were proved to be all that were expected, regarding both speed and economy.

Considering all the economies inherent in drill carriage work, as detailed in Part I of this article, the conclusion, therefore, is that in a heading where the length will justify the first cost and where rapidity of progress is of consequence, the drill carriage is essential for economical work. This is especially so where a bottom heading is used and where really long tunnels are to be driven. Of course, when a top heading is used and the slowly excavated bench governs the rapidity of progress the drill carriage is of less economical value.



13.—AFTER DRILL BAR HAD BEEN JACKED IN PLACE THE CARRIAGE WAS HAULED TO SIDING, LEAVING I-BEAM SUPPORTED BY GALLOWS FRAME UNDER WHICH MUCK CARS PASSED

12.—I-BEAM OF SIMPLE CARRIAGE EXTENDED ON ROLLER TO CARRY DRILLS OVER MUCK PILE INTO HEADING WHERE DRILL BAR IS BEING SET

A MODEL CARRIAGE

To design an ideal heading drill carriage features from several of those described might well be used. In the Carter carriage the idea of having the drilling equipment slide on the cantilever arm is its principal novelty and most valuable feature. In order to obtain sufficient reach in its beam to extend out over 25 ft. or so of muck pile this beam must be a pretty substantial affair and, therefore, heavy. To obtain the greatest flexibility with the greatest economy in both labor and materials the writer would advise two trucks. If the Carter carriage were used, very much as shown in Fig. 8, only with a very much larger arm and with an additional roller car in front, an almost ideal carriage could be obtained. The rear truck, to which the beam is hinged vertically, should also provide for a lateral swing. This could be arranged in a vertical screw which would also provide a vertical adjustment similar to the one shown in the third Lœtschberg carriage, Fig. 7. The forward truck would be similar to the forward truck in the simple carriage used in Montreal, shown in Fig. 3. The weight of the rear truck would depend entirely on the weight and length of the cantilever beam and entirely independent of the drilling equipment. All axles should be either provided with springs or give vertical play so that the wheels would always follow the local irregularities of the track. This enormously reduces the number of derailments.

When moving in and out of the heading the two trucks would be separated so that the forward or roller truck would be well toward the front end of the beam. This would give the outfit perfect equilibrium and flexibility in passing switches, curves, etc. As the rear car will naturally be the heavier it would be better to hold the drill car over or near the forward car when moving. This would not, however, be absolutely essential.

After a blast the track, made up of rails riveted to slick sheets, as described in the case of the Mount Royal headings, would be cleared to within 25 or 30 ft. of the face, the muck being thrown to the sides. The carriage would then be run in until the front car was hard up against the muck pile, and the rear car shoved ahead until hard up against the front one. If the drill bar were close to the forward car, arrangement would have to be made to hold it from passing the big roller, letting the beam slide under it as the rear car and beam were pushed ahead. When the beam had thus been advanced, approximate vertical and lateral adjustment could be made, after which the rear car would be braced down from the roof and the drill bar slid ahead into position. Probably the only further adjustment necessary would be a slight lateral swing to make the bar fit the heading.

15.—FRONT END OF DRILL CARRIAGE BEAM SHOWING HORIZONTAL BAR IN PLACE AND DRILLING IN PROGRESS

14.—REAR OF MUCK-HANDLING DRILL CARRIAGE WITH CANTILEVER BEAM EXTENDED

As soon as the bar was tight the beam would be disconnected, the rear car loosened and drawn back from the front one, so as to get the beam stably supported, and the whole carriage drawn back, light, to the passing track. The mucking would then proceed as usual. After the mucking was completed the carriage would be run back into the heading, the above process reversed, and the drills brought back for the ensuing blast. Of course, as previously mentioned, the drill bar should be very heavy and special grips or a jack leg provided to avoid bar rotation and vibration during the drilling. Provision should also be made on the carriage for carrying a certain amount of steel as well as all jacks, tools, manifolds, hose, etc.

A carriage embodying the features described could be built at a very small expense and would be simplicity itself in operation. As already pointed out the economies of this method of work are very great, both in time and cost, and in this carriage the maintenance and repairs would be almost negligible.

[*In the third and final installment of this series, which will be published next week, Mr. Brown describes the design and operation of two new types of drill carriage, one for bench work and the other for trimming the tunnel section. He also crystallizes the main points made in the three articles in a terse summing up of results and the inferences to be drawn from them.*—EDITOR.]

Steel Columns of Thick Material Relatively Weak

Progress Report by Special A. S. C. E. Committee on Tests at Bureau of Standards Proposes Extension of Original Program

THAT STEEL COLUMNS composed of thicker material are consistently lower in ultimate strength than light sections is the principal conclusion from the results of tests given in the progress report of the Special Committee on Steel Columns and Struts of the American Society of Civil Engineers, published in the December *Proceedings*, page 2753, and to be presented at the annual meeting Jan. 19. The original plan is extended to include columns with length ratios of 155 and, by testing short parts of the longer columns after their failure, columns with length ratios of 20. Tests of the latter for one type are reported; however, the uncertain influence of the previous testing of the material is recognized.

The following abstract covers the more important parts of this progress report, and the accompanying table gives, in condensed form, the average results of the tests reported. In the Engineering Record of May 1, 1915, page 549, will be found an abstract of the previously reported tests and of the results published by the American Railway Engineering Association for a similar series.

PROGRESS DURING YEAR

During the past year the Bureau of Standards has tested 110 additional columns, making a total of 180 now available for study and discussion. These include the light and heavy sections as shown in the last report, eighteen Bethlehem H-columns and eighteen Carnegie mine-section H-columns, light sections. These mine sections were donated by the Carnegie Steel Company.

Studies of the records of the seventy tests reported last year showed that it would assist in interpreting the results if comparisons could be made with columns of different slenderness ratios than the 50, 85 and 120 provided for in the original program. It was decided to extend the series, maintaining the same progressive ratio and adopting a new series with a slenderness ratio of 155, using three types, 1, 2 and 4, as probably giving sufficient information from which to draw conclusions.

After the first series of tests on light columns was completed it was suggested that it would be possible to take some of the long columns and cut pieces from them which would be available for tests of short struts. Three light and three heavy struts were cut from the plate-and-angle column, type 1, so as to give a slenderness ratio of 20. These were tested, and the results are shown in the table.

TO CHECK RESULTS ON EFFECT OF SECTION

It was thought advisable to begin an investigation to learn whether the drop in ultimate strength of the heavy sections was progressive as the thickness of the metal increased, and additional columns, with very much heavier metal, are to be provided by the Bureau of Standards. The committee has chosen one set of three columns of type 1, slenderness ratio 85, with metal 13/16 and ⅞ in. thick, and an area of 28.61 sq. in. as against 11.475 sq. in. for the original light sections, and 22.19 sq. in. for the original heavy sections. Three slenderness ratios, 50, 85 and 120, have been chosen for columns of type 5, an 8-in. Bethlehem H-section, with an area of 26.64 sq. in. as against 9.17 sq. in. for the original light section, and 18.27 sq. in. for the original heavy section. When the tests are completed this additional series will be of value when compared with the lighter sections of the same types.

Failure may frequently be due to the fact that thin outstanding legs cripple before the main section of the column is seriously affected by the load, and therefore types 4, 7 and 8 were selected to determine the effect of a square corner or bulb on the edge of the outstanding legs. Study seems to show very little difference in the results, so far as the types are concerned, but there is a marked difference in favor of the thin material. The general falling off of the ultimate strength for heavy sections carries through all the other types of columns, and it will be noted that this is also true for the Bethlehem H-columns, which are solid rolled sections, as well as for the riveted sections.

RESULTS FOR SHORT COLUMNS

The study of the stress-strain curves for the short columns with a slenderness ratio of 20 indicates that, though the heavy sections of these short columns have a unit ultimate strength considerably higher than

AVERAGE RESULTS OF TESTS ON STEEL COLUMNS

Each value is the average of three tests.

Type	Length ratio, l/r	Average ultimate strength in pounds per square inch	
		Light sections	Heavy sections
1 Built-up I-section	20	36,400	44,400
	50	32,700	29,200
	85	31,200	28,100
	120	28,300	25,400
2 Box section, 6-in. channels	50	33,900	32,300
	85	32,600	30,600
	120	29,300	28,100
3 Box section, 5-in. channels	50	34,100	29,500
	85	32,400	28,000
	120	30,600	26,900
4 8-in. I-beam and 2 channels	50	36,900	29,100
	85	34,000	26,600
	120	31,900	23,900
5 8-in. Bethlehem H-section	50	38,000	35,400
	85	34,300	32,300
	120	32,000	30,000
6 10-in. I-beam and 2 plates	50	31,600	32,100
	85	29,100	26,800
	120	27,200	24,800
10 Built-up box-section	50	35,800	31,800
	85	32,100	28,300
	120	28,400	26,300
7 Built-up bulb I-section	50	33,400	.....
	85	31,600	.....
	120	28,100	.....
8 Z-bar section	50	35,700	32,900
	85	32,800	29,400
	120	29,700	27,300

that of the light sections, the yield point of the heavy sections is lower than that of the light sections. Until tests can be made on short columns with the same slenderness ratio, which have not been previously tested, the committee does not care to do any more than call attention to these relative yield points, with the thought that this information may indicate the way toward the correct solution.

In order that the subject may have careful investigation, the Bureau of Standards is now making a series of re-tests on the steel from each melt number. These tests are to be made on short specimen sections in compression as well as in tension, and it is to be hoped that they will throw additional light on the problem.

YIELD-POINT INDICATIONS

There has been no attempt to indicate a yield point for the columns with a slenderness ratio of from 50 to 120. It is true that for the columns with a slenderness ratio of 20 there is a clearly indicated yield point, and the committee has given this question careful study to see if such a yield point can be accurately determined for the longer columns. From the study of this series of tests it seems that the initial sets occurred at very small loadings, and that these initial sets could be measured, provided the instruments could be obtained precise enough for the purpose. It would seem from the tests thus far studied that the yield point for the short columns is appreciably below the ultimate strength, but for longer columns, in which bending action is shown, the yield point and the ultimate are probably very close together.

The voluminousness of these records precludes their complete publication by the society, but arrangements will ultimately be made whereby copies will be filed in the library, to be available for those who desire to study them in detail. The committee desires to express its appreciation of the cordial assistance it has received from Dr. S. W. Stratton, director, and Dr. G. R. Olshausen, engineer-physicist, of the Bureau of Standards. George H. Pegram is chairman, and Lewis D. Rights is secretary of the committee.

Unique Helical Stairway Is Within Center Well

Tower in Southwest Museum, Los Angeles, Contains Probably the Only Reinforced-Concrete Stairway of Its Kind in the World

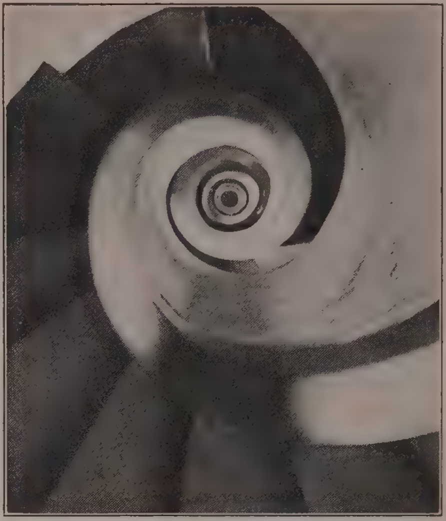
By FRANK REED
Los Angeles, California

THE TOWER of the Southwest Museum in Los Angeles, Cal., contains what is believed to be the only helical stairway of its kind built of concrete to be found in the world. It is, for its purpose here, an improvement over Sir Christopher Wren's masterpiece, the spiral stairway ascending the interior wall in the tower of St. Paul's Cathedral, London. The Southwest Museum helical staircase is built inside a well in the center of the tower, thus not only preserving for shelves or mounted objects the entire interior wall space of the tower, but also supplying on its own exterior wall additional space which may be employed for museum purposes. A short spiral stairway of a different type was described in the Engineering Record of Nov. 6, 1915, page 574.

The tower containing the stairway is seven stories in height, with three mezzanine balconies in the three upper stories, giving the equivalent of ten stories. The tower is 35 ft. square, and is supported by twelve columns and external walls 8 in. thick, reinforced with steel. It rests on a solid concrete slab or raft 3 ft. 6 in. thick. The total height is 125 ft. and the weight is 1000 tons. The construction was carried on continuously, a story being poured at a time.

STAIRCASE WELL

The staircase well is 9 ft. 2 in. in external diameter and is supported by four corner columns with 8-in. walls between them, with light and ventilation openings at each story. The stair is known as a caracol, on account of the likeness to a snail shell presented by a vertical view, as shown in one of the photographs. With one exception it is the only helical staircase in America having a hollow center, the other one being an ancient stone staircase in the tower of the cathedral in the city of Mexico. The stairway contains 160 steps with 7½ in. rise each, and was built around a galvanized iron form in the shape of a pipe, while wooden forms were placed for the stairs. Material was prepared at a special rock-crushing and sand plant located about one mile from the building, in a dry river bed. The mixture employed was a 1:5 concrete.



TOP VIEW SHOWING FOUR STORIES OF STAIRS

This stairway is called a caracol, which is Spanish for snail-shell.

VIEW OF STAIRS FROM ROOM IN TOWER

Dr. Charles F. Lummis, founder of the Southwest Museum, supervised personally the construction of this stairway. The museum was designed by Hunt & Burns, architects of Los Angeles, and built by the C. J. Kubach Company of the same city.

Sewage Works for Military Camp

Military camp sewage works at a site near Ripon, England, were completed last year. The data on which the designs were based were given by Arthur W. Smith, manager of the plant, in a paper presented recently at a meeting of the Royal Sanitary Institute and reported in the *Surveyor*. The camp occupies an area of about 1080 acres, and is designed to provide accommodation for a complete army corps of 42,000 men with 10,000 horses, and a large military hospital for general purposes, together with an infectious diseases hospital. It was expected that the water consumed would be 500,000 imp. gal. per day, made up as follows: Officers, 15 imp. gal. per head per day; men, 8 imp. gal. per head per day; horses, 10 imp. gal. per head per day; and that the sewage from the camp would be of a very strong character. It was for the purpose of diluting this very strong sewage with the weak city sewage that suggested the idea of treating both sewages together. The city sewers take in a good deal of subsoil water, and it was intended to take as much sewage from the city as would make the total flow 1,000,000 imp. gal. per day. Experience has shown that the consumption of water in the camp exceeds the estimate, and amounts to about 700,000 imp. gal. when the camp is fully occupied.

The sewage disposal works consist of two screening tanks, four deep and four long subsidence tanks—the deep tanks being on the Dortmund principle, the long tanks having floors with a back fall to the sludge pipes. The total tank capacity is 500,000 imp. gal., and the system is one of continuous flow. The percolating bacteria bed is rectangular in shape, 10,000 sq. yd. in area, the filtering media 6 ft. deep, consisting principally of slag, with a proportion of local gravel.

The sewage is distributed on the bed by eight reciprocating sprinklers. The effluent from the bed is conveyed to three humus tanks, also formed on the Dortmund principle, the final effluent being discharged into the river Ure.

All the tanks are of concrete construction throughout, and the walls are finished with artificial stone coping, made on the works of local gravel and sand. Work was commenced at the end of last March, and by the latter part of July a portion of the tanks and a section of the bed was ready to treat sewage, ten days before the main sewer was put into operation by camp sewage. The remainder of the tanks, beds, and pumping stations were fully completed by Sept. 1, and it is claimed that the short period occupied by construction constitutes a record.

Paving Maintenance Should Include Cost of Cleaning

Gus H. Hanna, Street Cleaning Commissioner of Cleveland, Makes Plea for Smooth Grouted Block Streets as Economy Measure

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FLUSHERS HAVE GIVEN BEST CLEANING RESULTS IN CLEVELAND

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CLEVELAND WHITE-WING REMOVING RUBBISH FROM BRICK STREET

THAT the cost of cleaning streets is properly chargeable to paving maintenance, and, therefore, should be given due consideration in the selection of types of street surfacing, was the contention of Gus H. Hanna, commissioner of street cleaning, of Cleveland, Ohio, in an address before the recent road congress organized by the chamber of commerce of Worcester, Mass. Flushers, he said, are not only the cheapest but the most satisfactory method of street cleaning with which Cleveland has had experience. As for types of surfacing, granite block or brick are easy to clean, provided the joints are grouted instead of being filled with bituminous material. Mr. Hanna concluded his paper with statistics dealing with street-cleaning costs in Cleveland. An abstract follows:

CLEANING, A MAINTENANCE CHARGE

It is a continual wonder that so little weight is given to cleaning cost when paving questions are settled. An annual expense of $500 a mile in repairing residence streets would be considered an appreciable item of maintenance, yet that figure for cleaning a mile of residence street through a season is extremely low. A cost of $500 for maintaining a mile of one kind of pavement for a year as against a cost of $1,500 for maintaining another kind would be sufficient grounds, in most cases, to decide in favor of the former material. Yet greater differences than this in cleaning coat as between competing types are blandly overlooked.

A street cleaner looks for two qualities in a pavement. It must be smooth and particles of litter must not stick to the surface. The question of smoothness opens up the whole matter of durability. Any material that deteriorates and roughens becomes more difficult each year to clean. Any neglect of needed repairs means a larger cleaning bill until the repairs have been completed.

Additional calculation of cleaning expense must be made for all bituminous pavements on account of the sticking of particles of litter to the surface. These surfaces are never quite so clean as non-adhesive materials, and it costs from 25 per cent upward in additional cost to put them in a reasonably presentable condition, on account of this quality. In a new creosoted wood block pavement, when the oil is gradually working out, steel scrapers must often be employed, as flushing by water is not effective in removing the dirt from such a surface.

BRICK AND STONE EASILY CLEANED

The pavements most easily cleaned are brick and stone. Neither of them originates any form of dirt and both wash off readily. The only ground for discrimination between them is on the question of smoothness, where brick has a slight advantage as a rule. But in the use of these materials the choice of a filler is all-important. A bituminous filler has all the disadvantages of a bituminous surface, from a cleaner's standpoint, and some others besides. Being softer than the brick or block, it recedes, leaving a crevice that invites the lodgment of dirt. With the edges of the brick or block unprotected it is sure to roughen, thus adding to the difficulties of cleaning.

CLEANING COSTS

West Fourteenth Street, in Cleveland is a grouted brick thoroughfare that has been paved ten years and is in good enough condition to serve as a model of minimum cleaning cost. This street has a traffic of about two vehicles a minute. It has been cleaned, on an average, five times a week, being flushed by night and hand-swept in the daytime. The sweeper worked almost exclusively in the gutters, as most of the dust on such a pavement will be blown to the curbing in dry weather. The cost, per cleaning, amounts almost exactly to 15 cents per 10,000 sq. ft., called a "square," and used as the unit of calculation. This is the lowest figure obtained in Cleveland on any type of pavement. The cost on the best asphalt pavement would be not less than 20 cents and would rise to 30 as the surface became wavy or rough. A wood block pavement costs practically $1 a square to clean in its initial condition, and it will be at least two years before the oil will have dried out sufficiently to admit of its being cleaned for 30 cents a square. A tar-filled block pavement will cost not less than 30 cents per square, and, as the filler disappears and the blocks roughen, this cost will amount to 60 cents or more.

In the case of a pavement 40 ft. wide, there are about twenty-one squares to the mile. As between a material that can be cleaned for 15 cents and one that can be cleaned for 30 cents, there is a difference of $3.15 per mile per cleaning, a difference of $15.75 per week, of $630 per season of 40 weeks, and $6,300 in ten years. And if instead of 30 cents the cost of cleaning the pavement mounts to 60 cents per square, as is not uncommon under conditions of wear, the excess of cleaning cost will be $1,800 for a year, or $18,000 for a decade above the figures shown to be attainable on West Fourteenth Street.

PROMPT REPAIRS NEEDED

Cleaning costs can be greatly reduced by a policy of prompt repairs. Mr. Hanna believes in the continual patrol of all city streets by men whose duty it is to discover defects in pavements and prescribe repairs. Even from the standpoint of repair cost such a system saves money. When cleaning is considered, as well as repairs, the saving of a patrol system is very great.

New Formulas and Diagrams Give Deflections of Beams Under Any Loading

Application of Area-Moment Method to the Computation of Deflections of Simple Beams with Constant Moment of Inertia

By CHARLES A. ELLIS
Professor of Structural Engineering, University of Illinois

APPLICATION of the area-moment method to the problem of finding the deflection of simple beams of constant section is much simpler than the usual method of deriving and integrating the equation of the elastic curve. Furthermore, the new formulas thus derived can be given in terms of factors easily obtained from diagrams to facilitate the computation for deflection of any point, due to uniform loading and to any number of concentrated loads.

General formulas will be derived for the cases of a single concentrated load and of a uniform loading, and useful diagrams will be given, with an example of their application. It will be shown that these diagrams can also be used to find the intermediate reaction of a continuous beam on three supports.

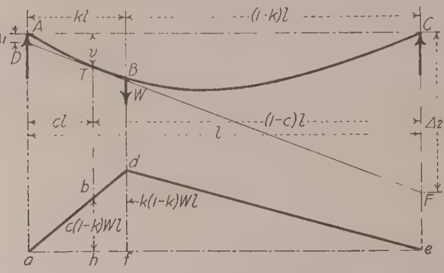


FIG. 1—THEORETICAL DEFLECTION RELATIONS FOR SINGLE CONCENTRATED LOAD

SINGLE CONCENTRATED LOAD

Let the line ABC in Fig. 1 represent the elastic curve of a bent beam simply supported at A and C and carrying the single load W at B, a distance kl from A. The line ade represents the bending moment. The deflection v at any point T, at the distance cl from A, can be found by using the line DTF tangent to the elastic curve at T, and the end intercepts AD = Δ_1, and CF = Δ_2. Thus, $v = \Delta_1 + c(\Delta_2 - \Delta_1)$.

To find the vertical deflections Δ_1 and Δ_2 from the tangent at T, apply the area-moment method (as given in textbooks on mechanics or Greene's Trusses and Arches, Vol. 2, page 103) to the areas abh and bdeh of the moment diagram. Assuming constant moment of inertia, I, the value of Δ_1 is equal to the moment of the triangle abh about Aa divided by EI. Similarly the value of Δ_2 is equal to the moment of the area bdeh about Ce divided by EI.

Using the dimensions and usual notation, shown on the figure, and noting that the area bdeh equals the area of the triangle def plus the triangle adf minus the triangle abh, there is found:

$$\Delta_1 = \frac{c(1-k)Wl(cl/2)(2cl/3)}{EI}$$

or

$$\Delta_1 = \frac{2c^3Wl^3(1-k)}{6EI}$$

Using the moments of the triangles composing the area bdeh and reducing,

$$\Delta_2 = \frac{Wl^3}{6EI}(1-k)(2k-k^2-3c^2+2c^3)$$

Then

$$v = \Delta_1 + c(\Delta_2 - \Delta_1)$$
$$= \frac{Wl^3}{6EI}(2ck - 3ck^2 - c^3 + ck^3 + c^3k) \qquad (1)$$

When c is greater than k, the point T lies between B and C, and by analogy, interchanging c and k, there is found

$$v = \frac{Wl^3}{6EI}(2ck - 3c^2k - k^3 + c^3k + ck^3) \qquad (2)$$

If, in general, the value of v is

$$v = \frac{Wl^3}{6EI}F \qquad (3)$$

the value of F is given by the parenthesis of equation 1 when c is less than or equal to k, and by the parenthesis of equation 2 when c is greater than k.

MAXIMUM DEFLECTION—DIAGRAM FOR *F*

The maximum deflection occurs in the longer segment when c is greater than k and the tangent DTF is horizontal. It is obtained by equating the values of the deflections of the ends from this tangent. There is thus found

$$c = 1 - \sqrt{(1-k^2)/3} \qquad (4)$$

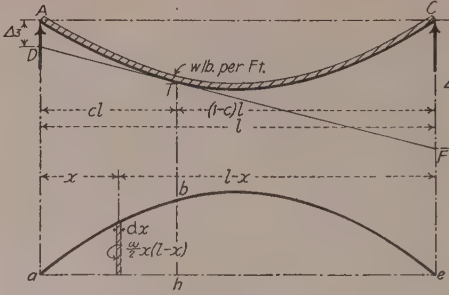


FIG. 3—THEORETICAL DEFLECTION RELATIONS FOR UNIFORM LOADING

Since the limits of k are 0 and 0.5, all values of c for maximum deflection under a single load will fall between 0.4227 and 0.5—hence the point of maximum deflection is between the load and the center of the span and always near the center.

Fig. 2 gives the values of F for various values of c and k, and also the values of c for maximum deflection under a single load.

UNIFORM LOAD EQUATION AND DIAGRAM

By a similar derivation, based upon Fig. 3 and the notation there shown, using the

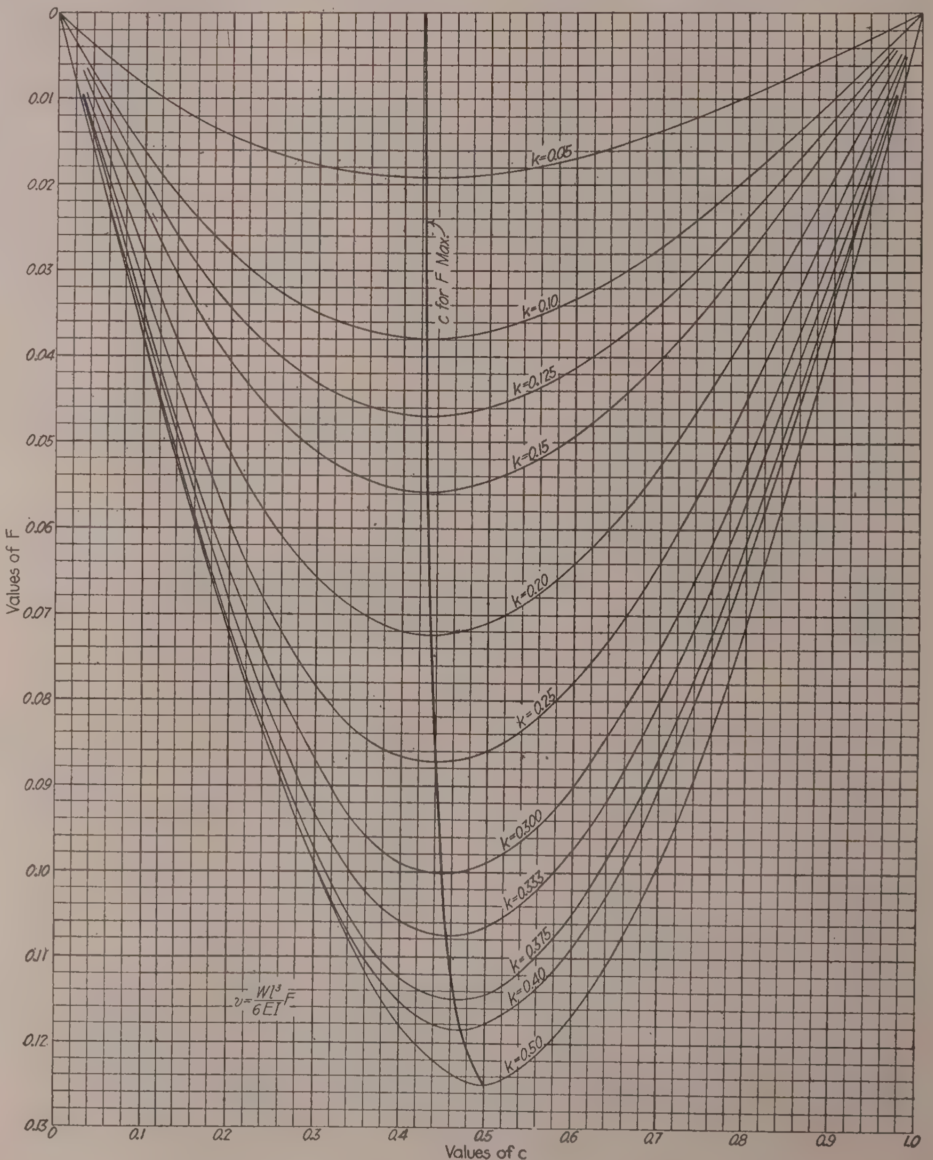


FIG. 2—VALUES OF COEFFICIENTS *F* FOR SINGLE CONCENTRATED LOADS

moment of the area abh about aA to give Δ_3 and the moment of the area beh about Ce to give Δ_4, there is obtained

$$\Delta_3 = \frac{wl^2}{2EI}\int_0^{cl} x^2(l - x)\,dx$$

$$= \frac{wl^4}{24EI}(4c^3 - 3c^4)$$

and

$$\Delta_4 = \frac{wl^2}{2EI}\int_{cl}^{l} x(l - x)^2 dx$$

$$= \frac{wl^4}{24EI}(1 - 6c^2 + 8c^3 - 3c^4)$$

Then

$$v = \Delta_3 + c(\Delta_4 - \Delta_3)$$

$$= \frac{wl^4}{24EI}(c - 2c^3 + c^4)$$

$$= \frac{(wl)\,l^3}{24EI}J \qquad (5)$$

The values of J may be found from Fig. 4, and the resulting value of v easily computed for any desired point. In these equations, of course, the length l is in inches to agree with the values E and I, and wl is the total load uniformly distributed.

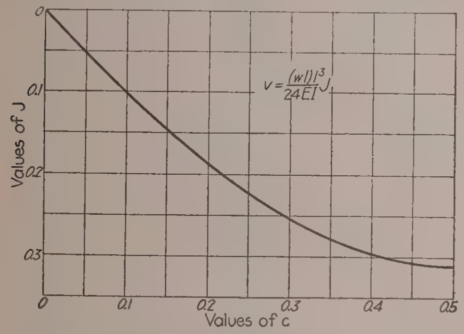


FIG. 4—VALUES OF COEFFICIENTS J FOR UNIFORM LOADING

APPLICATION OF DIAGRAMS

As an example of the application of the diagrams, consider a beam loaded as shown in Fig. 5. In computing v_1 due to W_1, c is 0.2 and k is 0.2, while for W_2, c is 0.8 and k is 0.3. Similarly, in computing v_2 for W_1, c is 0.7 and k is 0.2, and for W_2, c is 0.3 and k is 0.3. Entering the diagram, Fig. 2, with these values and using Fig. 4 to obtain the uniform load coefficients, the deflections v_1 and v_2 at each load, and v_c at the center are

$$v_1 = \frac{l^3}{6EI}\left(0.051W_1 + 0.052W_2 + 0.186\frac{wl}{4}\right)$$

$$v_2 = \frac{l^3}{6EI}\left(0.052W_1 + 0.088W_2 + 0.254\frac{wl}{4}\right)$$

$$v_c = \frac{l^3}{6EI}\left(0.071W_1 + 0.099W_2 + 0.313\frac{wl}{4}\right)$$

The point of maximum deflection for the case of several concentrated loads can be found by trial, but it is evident that it will occur very close to the center of the span and differ but slightly from the value v_c found for the center deflection.

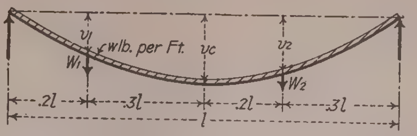


FIG. 5—EXAMPLE OF COMBINED LOADING

CONTINUOUS BEAM ON THREE SUPPORTS

The reactions of a continuous beam on three supports can be obtained by the use of the coefficients given in the diagrams. Since the deflection at the intermediate support must be zero, the intermediate reaction R_2 must produce the same deflection as that produced by the given loading upon the assumption that the beam is simply supported at the ends. For instance, if the beam of the previous example be supported at the center, the deflection produced by the reaction R_2 at that point would be

$$\frac{R_2 l^3}{6EI} \times 0.125$$

This is equated to the expression for v_c previously given, and the value of the intermediate reaction reduces to

$$R_2 = \frac{0.071W_1 + 0.099W_2 + 0.313wl/4}{0.125}$$

If the center reaction be known, the end reactions are statically determinate. A similar computation can be made for any continuous beam with constant moment of inertia, any loading and unequal length of adjacent spans.

The diagram, Fig. 2, complies with Maxwell's theorem of reciprocal deflections. For example, $F = 0.0658$ when k is 0.2 and c is 0.3, and also when k is 0.3 and c is 0.2. The coefficient F, and hence the deflection, will remain constant for any interchanged values of k and c.

Government Has Now Inventoried 41,607 Miles of Railroads

SINCE the publication in the Engineering Record of Nov. 13, 1915, page 601, of a table showing the mileages covered to Sept. 30, 1915, by the various field parties of the Division of Valuation, Interstate Commerce Commission, another table has been issued by Thomas W. Hulme, general secretary of the Presidents' Conference Committee, bringing the figures up to Nov. 30. In the months of October and November the work of all field parties was practically completed on the Chicago & Eastern Illinois and the Cleveland, Cincinnati, Chicago & St. Louis, as was that of the road and track parties of the Boston & Maine. Considerable mileage was covered on some of the large Western systems, notably the Great Northern, the Rock Island and the Santa Fé.

PROGRESS OF FIELD INSPECTION, NOVEMBER 30, 1915, FOR GOVERNMENT VALUATION OF RAILROADS

Road	Date Division of Valuation forces began work	Miles of road	Total miles inspected and inventoried to date					Total miles "Adjacent Similar Land" inspected
			Road and track	Bridges	Buildings	Signals	Telegraph and telephone	
Eastern Group								
Boston & Maine	4–29–14	2,434	2,400	1,026	1,026	1,334	2,326	1,520
Chicago & Eastern Illinois	5–2–14	1,140	1,140	1,140	1,140	1,140	1,123	1,100
Cleveland, Cincinnati, Chicago & St. Louis	8–24–14	2,262	2,247	2,262	1,783	2,262	2,262	....
Pennsylvania	1–1–15	5,919	1,395	1,072	1,072	890	1,284	511
New York, New Haven & Hartford	3–31–15	2,046	873	58	22	....	495	290
Boston & Albany	4–21–15	392	360	252	17	25	90	....
Chicago, Indianapolis & Louisville	5–25–15	610	548	610	610	....	610	....
Ann Arbor	6–1–15	292	292	292	292	292	292	286
Chicago, Terre Haute & Southeastern	7–26–15	362	232	....	....	362	362	....
Maine Central	8–14–15	1,057	102	....	....	....	63	....
Bangor & Aroostook	8–16–15	626	172	....	....	....	....	....
Vandalia	8–16–15	910	526	542	....	....	805	....
Philadelphia & Reading	11–4–15	1,582	41	....	....	....	....	....
Total	....	19,632	10,328	7,254	5,962	6,305	9,712	3,707
Western Group								
Texas Midland	....	111	* 111	111	111	111	111	111
New Orleans, Texas & Mexico	....	173	* 173	173	173	173	173	173
Kansas City Southern	....	878	* 878	878	878	878	878	878
San Pedro, Los Angeles & Salt Lake	....	994	* 994	994	994	994	994	994
Elgin, Joliet & Eastern	....	211	* 211	211	211	211	211	211
Western Pacific	....	981	* 981	981	981	981	981	981
Quincy Western	....	6	* 6	....	....	....	....	....
Missouri Southern	....	54	* 54	54	54	54	54	54
Mississippi River & Bonne Terre	....	54	* 54	54	54	54	54	54
Arizona & Swansea	....	21	* 21	....	....	....	....	....
United Verde & Pacific	....	26	* 26	....	....	....	....	....
Cape Girardeau Northern	....	106	* 106	106	106	106	106	....
Spokane & British Columbia	10–20–15	36	* 36	....	....	....	....	....
Butte, Anaconda & Pacific	10–9–15	62	* 62	....	....	....	....	....
Minneapolis, St. Paul & Sault Ste. Marie	5–1–14	4,125	2,381	404	404	404	None	500
Great Northern	5–3–14	7,321	5,403	2,705	2,705	3,504	7,127	592
Rock Island lines	8–1–14	7,680	6,746	3,579	3,579	870	7,210	891
Chicago & North Western	9–2–14	8,346	91	91	91	91	91	91
St. Louis Southwestern	11–12–14	1,568	747	747	747	....	747	747
Illinois Central	11–18–14	5,960	2,043	1,819	1,819	1,620	4,077	2,178
Santa Fé	12–4–14	11,117	1,707	1,109	1,109	....	4,748	None
Southern Pacific	1–3–15	6,906	248	....	....	561	705	....
Chicago, Milwaukee & St. Paul	5–22–15	9,611	1,609	None	None	....	None	498
Total	....	66,347	24,688	14,016	14,016	10,612	28,267	8,953
Southern Group								
Norfolk Southern	2–27–14	903	* 903	903	903	903	903	....
Atlanta, Birmingham & Atlantic	2–19–14	658	* 658	658	658	658	658	....
Central of Georgia	7–8–14	1,972	1,972	1,959	1,902	1,972	1,972	....
Savannah & Northwestern	2–18–15	109	109	109	109	....	109	None
Charleston & Western Carolina	5–29–15	341	341	None	None	....	341	None
Georgia Southern & Florida	1–2–15	392	392	392	392	392	None	None
Hawkinsville & Florida Southern	1–3–15	96	96	96	96	96	33	None
Macon & Birmingham	1–25–15	97	97	97	97	97	67	None
St. John's River Terminal	1–21–15	7	7	7	7	7	None	None
Mobile & Ohio	6–15–15	1,114	879	None	None	None	791	None
Okolona Branch	....	39	39	None	None	None	39	None
Southern	7–14–15	7,000	681	None	None	None	475	None
Southern in Mississippi	9–15–15	292	268	None	None	None	None	None
Virginia	9–8–15	488	149	149	149	None	None	None
Total	....	13,508	6,591	4,370	4,313	4,125	5,388	....
Grand total	....	99,487	41,607	25,640	24,291	21,042	43,367	12,660

*Field work on roadway and track parties completed.

Monolithic Brick Paving Slabs Show High Bond

Tests Begun at University of Illinois to Determine Feasibility of Reducing Concrete Base Thickness

By C. C. WILEY
Instructor in Highway Engineering, University of Illinois

TO COLLECT evidence in support of the assumption that the cost of brick paving can be considerably lowered by reducing the thickness of the concrete base when the monolithic, instead of the sand-cushion, form of construction is used, the civil engineering department of the University of Illinois has undertaken a series of tests of brick pavement slabs, and the results from the breaking of the first group of specimens are given herewith. The ordinary brick pavement with a sand cushion consists essentially of two separate slabs, unbonded. The strength of the pavement, therefore, is determined largely by the strength of the individual slabs. In the monolithic type of pavement described in the Engineering Record of July 10, 1915, the blocks are laid on a thin mortar bed before the concrete base has set and, when grouted, the structure becomes a solid unit. There appears, therefore, to be no good reason why the ordinary base thickness, when a sand cushion is employed, can not be reduced when the monolithic type of construction is followed.

PAVEMENT SLABS TESTED

The first set of test slabs consisted of only four specimens, one of each kind, as follows:

Slab 1—A 4-in. base of 1: 2: 4 concrete, while still unset, was covered with a ⅛-in. layer of a 1: 5 dry mixture to form a smooth bed on which to lay the brick. Three-inch wire-cut-lug brick were laid on this base, tamped, and grouted with a 1: 1 grout. The slab was allowed to set for 24 hr. and was then covered with sand and kept moist until tested. The slab consisted of six courses of five brick each and measured 23 x 45 in.

Slab 2—The second slab was built like Slab 1 except that 4-in. wire-cut-lug brick were used.

Slab 3—A 1-in. base of 1: 3 dry mixture was prepared. Four-inch wire-cut-lug brick were laid on this base and grouted. The length and width were the same as Slab 1.

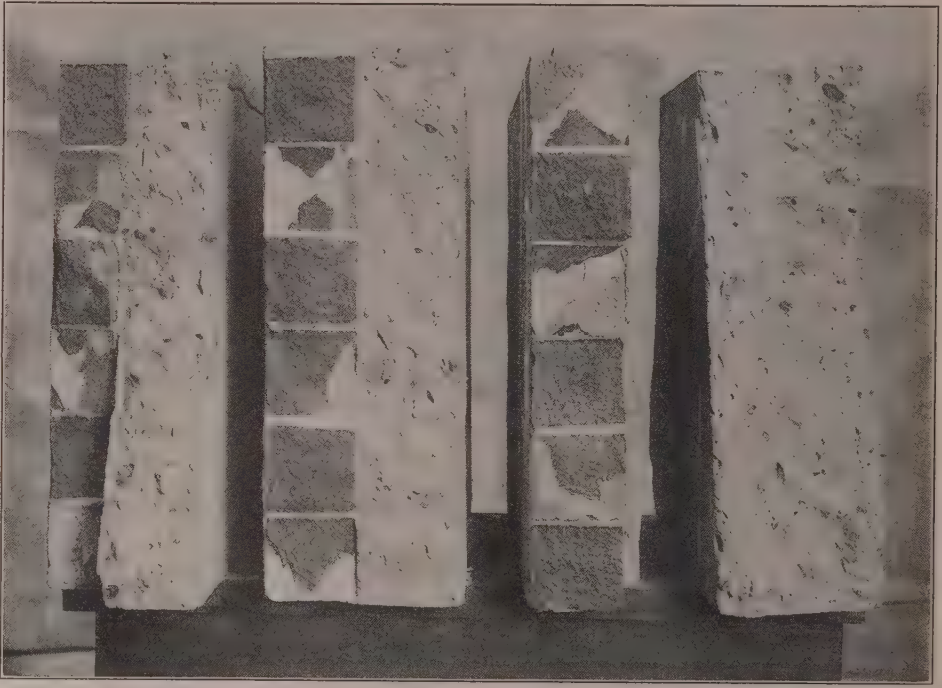
Slab 4—This was a concrete slab 7 in. thick and intended to represent standard concrete pavement construction. The proportions were 1: 2: 3, using a good gravel aggregate. The length and width were the same as Slab 1.

The specimens were tested when 28 days old as simple beams on a 42-in. span with the load applied at the one-third points. The numerical results of these tests are summarized in the table.

RESULTS OF PAVING SLAB TESTS; SPECIMENS 28 DAYS OLD

Slab No.	Total thickness, in.	Base thickness, in.	Brick thickness, in.	Total load, lbs.	Modulus of rupture, lbs. per sq. in.
1	7 3/16	4 3/16	3	13,100	465
2	8¼	4 ¼	4	21,500	580
3	5	1	4	6,700	490
4	7 1/16	7 1/16	..	12,500	460

The accompanying photograph shows the fractured faces of the four slabs. In Slab 1 it will be noted that three courses of the brick broke squarely across, while the other three separated at the joints, but with many indications of a very strong bond between the grout and the brick. There was a slight separation of the brick from the base, as evidenced by the different planes of fracture in the brick and concrete. In Slab 2 this separation of the brick and concrete is not found, indicating a relatively high bond between them. A very high bond between the brick and the grout filler is shown by the fact that in all three courses which broke at the joints a thin layer of brick pulled away from the body of the brick and remains adhering to the filler, which is still intact. In both of these slabs the thin layer of dry material is quite distinct. It proved to be quite porous and soft as compared with the concrete base, as would be expected from the very lean mixture used. Slab 4 shows a concrete of high quality, very uniform and dense. Strong adhesion between the cement and aggregate is evidenced by the numerous fractured pebbles.


FRACTURED FACES OF FOUR PAVING SLABS AFTER BEAM TESTS

HIGH BOND DEVELOPED

Since only a single slab of each kind was tested, the data are insufficient for conclusions as to economical dimensions or strength of the brick slabs as compared with concrete slabs. On the other hand, the three brick slabs are quite consistent in indicating that the wire-cut-lug brick makes it possible to fill the joints completely with grout, and that when this is done a very high bond will be developed between the brick and the filler. The three brick slabs further indicate that a bond can be developed between the brick and the base, or, in other words, that the brick and concrete can be united into a monolithic structure.

In the original pavement of this type built at Paris, Ill., no attempt was made to secure a bond between the brick and the base, the desire being simply to secure a firm, unyielding bed for the brick. In making the test specimens, however, the concrete was mixed to a quaking consistency or slightly wetter than had been the practice at Paris, and it was found that the ⅛-in. dry layer absorbed sufficient water to become well moistened by the time that the brick were laid. It was thought at the time that there would be considerable adhesion between the brick and the base. This opinion was borne out by the results of the tests. It was also thought that it might be desirable to develop this bond, so as to make the slabs truly monolithic, by increasing the amount of cement in the ⅛-in. layer to at least the same proportion as is used in the concrete base. It appears desirable that this ⅛-in. layer should be at least a 1: 3 mixture in order to avoid a soft, porous stratum in the middle of the slab, and at the same time firmly unite the brick with the base. This richer mixture has been used in several pieces of pavement constructed since these tests were made, and was adopted by the Illinois State Highway Department on a state-aid road near Monticello which was begun late in the fall. The new series of test slabs has also been made with a 1: 3 mixture in the ⅛-in. layer and should give some valuable data.

The department is indebted to Harvey C. Adams, president of the Danville Brick Company, of Danville, Ill., whose interest and co-operation in furnishing brick and other materials are largely responsible for making these tests a possibility.

THE CUBAN SOCIETY OF ENGINEERS, founded seven years ago, has grown up steadily until it now numbers 200 members, all, necessarily, graduated engineers and architects, besides some associates. Among the members are numbered the President of Cuba, himself a civil engineer and a graduate of an American university; the secretary of the National department of public works, and the foremost engineers in the country, both in Government service and private practice. The home of the society, at Paseo de Marti, 76, Havana, is centrally located and includes a carefully selected library and keeps on file technical journals from Europe and the Americas. The official publication of the society is the *Revista de la Sociedad Cubana de Ingenieros*, which is issued monthly.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Relief for Irrigation Settlers

SIR: My attention has been called to your editorial of Nov. 27, 1915, page 650, on the question of whether the irrigation settlers shall be given relief. While I heartily agree with most of it and indorse every word that Amicus Curiæ says, I wish to say that there has never been a hint of repudiation in this project. I was at the Washington (D. C.) conference in May, 1913. When repudiation was hinted at by one or two Senators and Congressmen, it was indignantly denied by every representative of every reclamation project, who considered it a gratuitous insult.

I have been a water user in this project ever since the government took it over from the Washington Irrigation Company. For seven years continuously, until Dec. 4 last, I was a trustee of the S. W. U. Association. The last three years I have been its president. I have met Secretary Lane at different times since the conference mentioned. the last time last winter in Washington, and I do not believe he is "losing faith in the Lane policy."

FARWELL MORRIS,
Former President, Sunnyside Water Users' Association.
Grandview, Yakima County, Washington.

Six Civilians Qualify as Lieutenants in Corps of Engineers

SIR: I take pleasure in sending you the following information:

As a result of the examination for appointment as probational second lieutenant in the Corps of Engineers, U. S. A., held Oct. 25-30, 1915, the nominations of the six successful candidates are about to be sent to the Senate. These are Gilbert D. Fish, New York City; George Mayo, Washington, D. C.; Paul T. Bock, New York City; Charles O. Boynton, San Francisco; Arthur P. von Deesten, Brooklyn, N. Y., and Edward N. Whitney, Madison, Wis. Mr. Boynton is a junior engineer who has been several years in the government service, under the Engineer Department.

The number of candidates who actually took and completed the examination was seventeen. In addition, three candidates withdrew during the progress of the examination, while two were found physically ineligible as a result of the physical examination which preceded the mental examination.

The nomination of the six successful candidates marks the completion of a vigorous effort on the part of the chief of engineers of the Army to secure thoroughly well qualified young engineers for appointment to the Corps of Engineers under the provisions of the river and harbor act approved Feb. 27, 1911.

The number of candidates presenting themselves for this examination in previous years was disappointingly small, and very few of the candidates who presented themselves had the necessary qualifications. In the period from January, 1912, to February, 1915, four examinations were held. The total number of persons who took the examinations was eleven; of these three were commissioned as probational lieutenants.

In order to secure a larger number of candidates the chief of engineers, on April 1, 1915, addressed letters to the presidents of all the approved technical schools, about fifty in number, requesting that they draw the attention of suitable graduates of their institutions to the opportunity for appointment as lieutenants in the Corps of Engineers. The chief of engineers also issued instructions to all of the district engineer officers in the United States to facilitate in every way the candidacy of junior engineers in the employ of the Engineer Department and of any other candidates who might make inquiry regarding the examinations.

Arrangements were made with the Civil Service Commission by which a special examination was held to permit candidates to establish eligibility for junior engineer as required by law.

As a result twenty-five persons were authorized to take the examination beginning Oct. 25; of these two withdrew before the examination, and one failed to appear, leaving twenty-two who presented themselves for the examination as already indicated.

It is anticipated that the next examination for appointment to the Corps of Engineers will be held at a convenient time after the termination of this college year.

DAN C. KINGMAN,
Chief of Engineers, U. S. Army.
Washington, D. C.

The Panama Slides

SIR: After thirty years of patient waiting, unwilling to put myself in the position of a prophet of evil, but myself even hoping against belief and the results of careful investigations, it seems to me the time has come to look back in order to take into account what has happened during this long period when the attention of the world has been centered on the Isthmian problem and now ask, What of the future?

In 1885, thirty years ago, it was my professional duty to make a careful investigation of the physical conditions at Panama to ascertain what would be the probable result of the plans of a sea-level canal, which was then contemplated.

The surveys, while not completed by the French engineers, were well advanced. The topography, ascertained by careful levelings, had made it possible to draw the contours with some precision. Also, diamond-drill borings had been made at all critical points to below the proposed level of the bottom of the canal in the backbone of the continental divide along the 9 miles of the high land then generally termed "Culebra."

The material disclosed by these borings had been examined and studied and the assumed stable slope had been decided upon. The channel was to have been 9 m. deep and 31 m. wide at the surface of the water (29½ ft. and 101½ ft. respectively).

From the surface of the ground to about 15 m. (49 ft.) the material was assumed to be hard clay, and the slope was to have been about 1 on 1. Below the clay the material was assumed to be a quasi rock and the slope was to have been about 1 on ½, with terraces about every 20 m. (66 ft.) 3 m. (10 ft.) wide.

In order to form an opinion of the stability of these slopes it was necessary for me to ascertain independently as closely as practicable the character of the material to be encountered. Fortunately I had access to the diamond-drill cores and to the reports of the Panama Railroad Company, which made mention from time to time of the effect of slides in its comparatively slight excavations, where they had entered the toe of the natural slopes of the surface at several points in the 9 miles of the heavy ground in the center of the Isthmus. It was seen from these reports that at times suddenly the track would be covered with sliding material several feet in depth and, in one instance, as I recollect it, to a depth of about 18 ft.

The cores from the diamond drills disclosed a great variety of material, and in a single core several apparently different kinds. In any one location there could be found many varieties in the length of the hole, which sometimes reached more than 300 ft. Some of the holes were vertical and some inclined, and all, to appearances, went through a great variety of strata. If the general character of the material could be called rock no engineer, experienced in excavations, would trust it, when disturbed or exposed to water and air.

From these studies I decided that the slope designed would not be stable. In order to ascertain where what I would consider a stable slope would extend to, I plotted the section as shown by the contours of the official reports, using the Culebra hill for one side of a proposed excavation. The results on that, the west, side of the cut are as follows: The section of the De Lesseps engineers, with a slope of 1 on ½, and the slope in clay 1 on 1, reached the surface 127 m. above the surface of the water and 90 m. from the center line of the canal (respectively 416.6 ft. and 295.3 ft.). A slope of 1 on 1 reached at the surface of ground 180 m. above the surface of the water and 190 m. from the center line of the canal (respectively 590.4 ft. and 623.4 ft.). A slope of 1 on 1½ reached 201 m., 300 m. from the center line of the canal (respectively 659.3 ft. and 984 ft.), but this slope cut through *behind* the summit of the hill and 40 m. (131 ft.) back of it, and this summit was 213 m. (about 700 ft.) high. A slope of 1 on 2 would come out 80 m. (262 ft.) *back* of the summit and 360 m. (1181 ft.) from the center line of the canal; yet this slope was not, in my opinion at the time, a stable one, and I then thought, and so stated (and results since then have confirmed it) that at least a 1 on 3 slope would be required.

The summit nearly opposite Culebra on the east side of the canal is nearly 230 m. (744 ft.) high, and others are as high. I went through the Culebra cut with Colonel Gaillard in January, 1911, and pointing up to where a break had started dropping down at Gold Hill, I asked him how high it was above the bottom of the canal. He replied 656 ft. I then related what I have stated above, and he complimented me by saying I was a prophet.

I am not quoting his remark or giving the results of my investigations in 1885—thirty years ago—for any selfish purpose, but to endeavor to show the American people, through the Engineering Record, that infinite patience is still required of them, and to urge them to brace up under the present serious disappointment to meet more serious results that may develop before a permanent channel is secured.

I have been told that the whole set of diamond-drill cores and all the data obtained during the De Lesseps régime were turned over at the time to the U. S. Government, and are, or were, in the State Department. If these data were available to our boards of engineers at a later date it is hard to understand why they decided that Culebra would stand firmly at an average slope of "three vertical on two horizontal".

The very terms used by the geologists who investigated the material would themselves be sufficient to put a practical engineer on his guard—such terms, for instance, as "indurated clay", and "argillaceous and calcareous sandstone", all of which material is likely to go to pieces under weather and water and especially under saturation and, if a correct term, internal supersaturation.

My opinion has never been asked and I always hesitated to give it, but being absolutely certain that the canal would be blocked to navigation if opened when it was proposed to do so, I felt it my duty as an American citizen to suggest that the opening of the canal should be postponed, as it would be much wiser to have the world's commerce wait awhile than to have it obstructed when once its streams had begun to flow through this waterway. The fact that 10,000,000 cu. yd. has held up 100 vessels at the present time, with the resulting inconvenience, cost and general disturbance of interoceanic traffic, is sufficient to attest the unwisdom of having opened the canal to navigation before it was ready for it.

ELMER L. CORTHELL, DR. SC.,
Civil and Consulting Engineer.
North Egremont, Mass.

[A copy of this letter was sent to General Goethals, with an invitation to comment on it. He replies that he considers comment on it unnecessary in view of the publication of his report on the slides. This report was published in full in the Engineering Record of Nov. 27, 1915, page 652.—EDITOR.]

Prejudicing the Young Engineer

SIR: I am pleased with your editorial paragraph on "Prejudicing the Young Engineer" in your issue of Dec. 18, 1915, page 745. College instructors and perhaps teachers generally are inclined to consider the letter of the law in the matter of public as well as private honesty both of action and purpose, particularly in those lines in which they themselves are not immediately concerned. And my experience goes to indicate that in this they are not unlike other people, but that as a rule, having no immediate connection with public or other business, they are inclined to criticism wherever they think they see something to criticise. In this they do no more than the newspapers do, but I think the instructor criticises as a rule with an honest purpose and the newspaper criticises in accordance with its political bias.

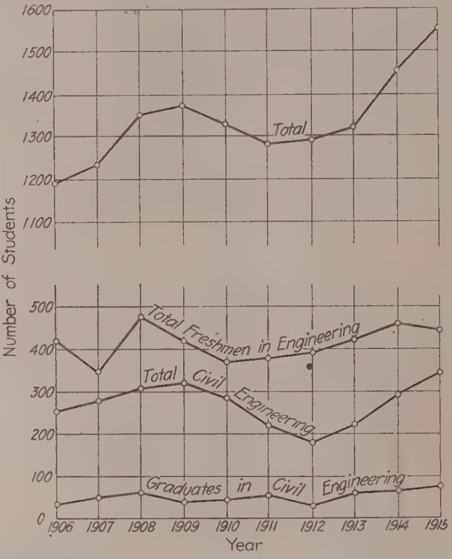
What the instructor should do, it seems to me, is, so far as he is able in the time at his command, to explain fully and frankly to his students methods, honest and dishonest, of doing business, and to try by both his own life and his teaching to impress upon them the desirability of a spirit of tolerance for the shortcomings of others and of intolerance toward their own shortcomings, not with a view to leading them to look lightly upon or to tolerate public dishonesty, but that they may judge upon known facts only and without prejudice.

He should teach them, too, to be slow to express criticism except when there is good ground, well proved, and the possibility of accomplishing a betterment.

WILLIAM G. RAYMOND,
Dean of the College of Applied Science,
State University of Iowa.
Iowa City, Iowa.

Why Is Registration in Civil Engineering Decreasing?

SIR: In connection with the article in the Engineering Record of Dec. 18, 1915, page 766, relative to enrollment in civil engineering, I am sending you herewith the data covering the department of civil engineering, University of Michigan, for the years 1906 to 1915 inclusive. I am also enclosing the total enrollment in the College of Engineering, and the freshmen enrollment. In our system of classification at Michigan there is no election made by the freshmen, and the work in the first year is all required and is identical for all students of engineering.



UPWARD TREND IN LATER YEARS SHOWN IN ENROLLMENT OF ENGINEERING STUDENTS AT UNIVERSITY OF MICHIGAN

Prior to 1911 the graduate school was not specially organized and all graduate students in engineering were enrolled in the College of Engineering and appear in the total enrollment in the engineering catalog for those years. In 1911 the graduate school was organized to include all graduate work on the campus. Since that time engineering students taking a fifth year's work for the Master's degree and candidates for the degree of Civil, Mechanical or Electrical Engineer, which is held equivalent to the Doctor's degree here, are enrolled in the graduate school and do not appear in the total engineering enrollment.

I have included in the civil engineering enrollment those graduate students whose entire work is in civil engineering. In addition to these, a large number of graduate students are taking a number of engineering courses, but are not enrolled as candidates for engineering degrees. All such are omitted. Our first semester enrollment this year is 32 behind the entire enrollment for last year. The normal increase, due to new men coming in the upper classes or the graduate school in February, is about 28 to 30, so that the total enrollment for 1915-1916 in the department of civil engineering should very nearly equal that of last year.

I think that we may seek for the decline in civil engineering registration in a number of causes. You will note from the chart that Michigan had her drop during the period 1908-1909 to the period 1911-1912, and that since the reorganization in the spring of 1912 there has been a fairly steady increase.

Undoubtedly the closing down of work on the Panama Canal and the New York Barge Canal, the decrease in the activity of the Reclamation Service and the suspension during the past few years of all except the most necessary railroad construction, have had their effect. Whenever a considerable number of engineers, particularly men who are not technical graduates but who have come up from the ranks and been in service for a number of years, are thrown out of employment they have a very decided tendency to check young men from going into the profession.

Possibly not enough work has been done in the way of bringing to the attention of the public at large and particularly to the teachers of high schools the very rapidly increasing field for engineering graduates in manufacturing, sales and other business engineering lines which have not been looked upon in the past as the field of engineers. We have had but little difficulty in placing our graduates in good positions. All of the correspondence relative to employment of alumni in my department passes through my hands, and at the present time there are no more men seeking changes than is normal at this time of the year. We have a record of perhaps ten men whose work is about to finish. We have advised every one of these men of three or four openings. In other words, the demand for our graduates remains a little ahead of the available supply.

I think it might be a good thing to go a little further in the investigation and try to secure answers to three or four questions other than have already been suggested.

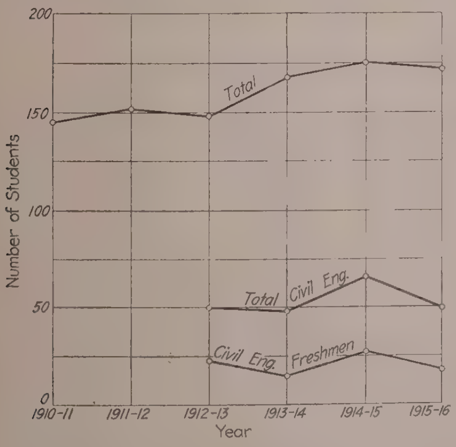
1. Are not the large schools, those having an enrollment in engineering of from 600 to 700 up to 1500, a little inclined to lose sight of the personality of the student and treat the students as so many units, each one of whom must go through a machine and acquire certain degrees of polish and at the end when they come out all of those who do not come up to the required specification are rejected? We are trying to remedy that criticism here at Michigan through the working of the Mentor and Assembly system, which has been one of Dean Cooley's developments and which has shown a most wonderful increase in the effectiveness of work, not only on the part of the students but on the part of the faculty. We have also aimed at the same thing by the adoption of our group system, which gives the men in their senior year a very much wider range of work than formerly, permits them to give a little special preparation for some particular line of work, and gives the faculty the opportunity of directing work of some of the students who either show a marked inclination and ability for certain lines or an apparent inability to handle the work of certain other lines.

2. Are the best results in teaching secured by the employment of men on the teaching staff who have grown up in the atmosphere of college and who have not come into contact, to any large degree, with the active work of the profession, who are thoroughly qualified, perhaps, on the theory of pure science but are to some extent lacking in the practical application of that theory in everyday work? Or, will better results be had if men are chosen for the various teaching positions who have had the training and then have been for a given number of years in practice?

It has been the privilege of the writer to go into university work after 25 years of practice in the profession. In the reorganization of the civil engineering department which took place in 1911 and 1913 the teaching staff was filled with men who had had from 10 to 18 years of active practice in the special line of work which they were asked to teach, while all instructors are chosen from men who have had 5 years or more of active outside work, not done in connection with a teaching position. This seems to be working well. I think that the criticism that was made at the outset that a man who had been 10 years in practice would never be able to teach theory has not been sustained. The present plan at Michigan has the merit of commanding the confidence of the student body and the cordial support of the alumni.

H. E. Riggs,
Professor of Civil Engineering, University of Michigan.
Ann Arbor, Mich.

Sir: The accompanying diagram shows the enrollment of engineering students at Washington University. You will note that the statements concerning the civil engineering students begin with the year 1912-13. This is due to the fact that students here did not choose between the engineering courses before that date. Furthermore, it seems to me that the time covered has been so short and the curves are so irregular that practically no conclusion with regard to general increase or decrease can be drawn from them.

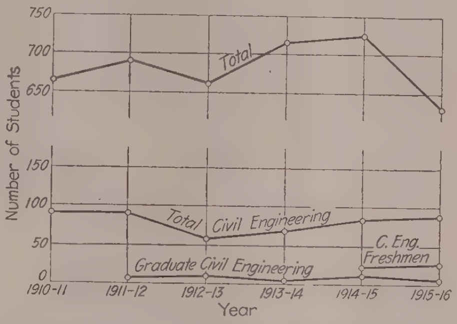


NO DEFINITE TREND IN ENROLLMENT AT WASHINGTON UNIVERSITY

Concerning the reasons for the conditions discussed, it seems to me the reasons given in the last half of your editorial, page 746, cover the essential situation.

J. L. Van Ornum,
Professor of Civil Engineering, Washington University.
St. Louis.

Sir: The accompanying diagram gives information concerning the registration in the Civil Engineering Department at the Georgia Tech. for the years 1910-11 to 1915-16 included. Until September, 1914, freshmen were in the general course. There has been a great increase in the number of students in the Civil Engineering Department. Probably this would have been larger had the head of this department been authorized to push the work as he desired.



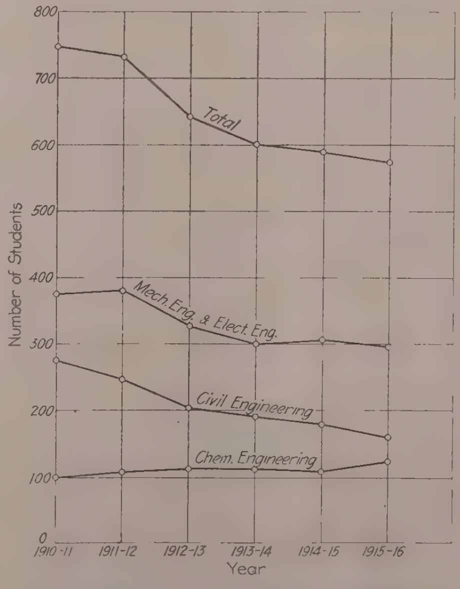
ENROLLMENT AT GEORGIA SCHOOL OF TECHNOLOGY—UNTIL 1914 FRESHMEN WERE IN GENERAL COURSE

In my judgment students are going into the electrical course rather than the civil because it is spectacular and appeals to the parents as well as the boy. They go into the mechanical often for business reasons, and the further fact that this work appears to give a man permanent residence. I believe, lastly, that there is an apparent rather than a real falling off in the Civil Engineering Department because of the subdivision of these departments into railway engineering, highway engineering, sanitary engineering, etc.

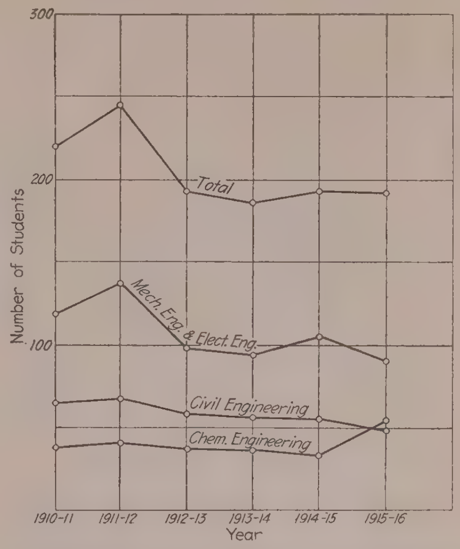
Thos. P. Branch,
Professor of Civil Engineering, Georgia School of Technology.
Atlanta.

Sir: The accompanying diagrams show certain statistics of attendance in the engineering courses of the University of Pennsylvania as to separate courses and totals, both for the attendance in the aggregate and that in the freshman class.

In my judgment, the popularity of engineering courses was artificially stimulated some years ago, when trusts were in their heyday, through sensational magazine articles concerning the rise of young captains of industry, and similar propaganda, which led to an abnormally large influx of aspiring youth upon the engineering schools.



CLASSIFICATION OF ENGINEERING STUDENTS AT UNIVERSITY OF PENNSYLVANIA



CLASSIFICATION OF FRESHMAN ENGINEERING STUDENTS AT UNIVERSITY OF PENNSYLVANIA

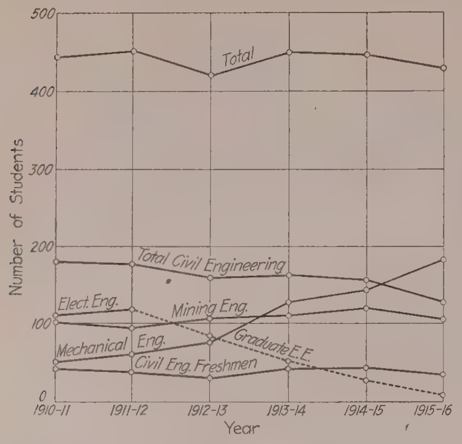
During a period which gradually drew to a close about a year ago, the engineering profession passed through some of its worst days. It is a well-known fact that, toward the end of that period thousands of engineers found themselves out of employment. Happily, that condition is now at an end and, in my judgment, there is little likelihood of its early recurrence. Its unfavorable effect upon the attendance on engineering schools, and especially on the sizes of the incoming classes, may be regarded as inevitable. That chemical engineering proved an exception to that tendency at this institution and, I understand, elsewhere, may be attributed to the fact that that field had been neglected in this country, and that its possibilities are at length being more clearly recognized, especially in the light of the changed conditions brought about by the European war.

I am strongly of the opinion that the decline in the attendance in civil engineering courses within the past few years will prove a temporary one, and that the curves will soon resume the ascending trend which they should exhibit under normal conditions—that is, under conditions of average business prosperity and industrial development.

Edgar Marburg,
Professor-in-Charge, Civil Engineering Department, University of Pennsylvania.
Philadelphia.

Sir: The accompanying diagram indicates the registration of students in engineering courses at Leland Stanford, Jr., University for the years 1910-11 to 1915-16, inclusive. The effect of the low registration in 1912 is being felt now, which, added to the general business depression along engineering lines on the Coast, accounts for the slight falling off in freshman civil engineers and in the total registration of engineering students.

It seems to me that prospective opportunity for employment influences many students when choosing their course. The policy of the Department of Civil Engineering has always been to discourage young men from taking up the study of civil engineering unless they feel reasonably certain that



CLASSIFICATION OF ENGINEERING STUDENTS AT LELAND STANFORD, JR., UNIVERSITY

they want to take up the work because they like it. The prospective student is told that he faces the probabilities of hard work and small pay, and must find part of his reward in the knowledge that his work is of the highest service to mankind.

Since the total registration of students in the University has increased from 1770 in 1910-11 to 2037 for the first semester of 1915-16, it is evident that the students are entering some of the other courses more freely than formerly. With us, the Departments of Economics and of Law show the greatest growth.

CHARLES D. MARX,
Professor of Civil Engineering, Leland Stanford, Jr., University.
Stanford University, Cal.

SIR: The article and editorial on the decrease in civil engineering registration in a number of universities, appearing in your issue of Dec. 18, 1915, are indeed instructive, but not entirely alarming, as one might conclude from the data given. To say just what the cause, or causes, of this decline are is rather difficult, since it most likely is not the same in all details for different schools. In the writer's opinion it is due mainly to preponderance of supply over demand, a condition in trade which, except in the case of monopoly, results in a drop in price. The oversupply of engineers has correspondingly decreased the value of their services. It is likewise logical to assume that if the demand exceeded the supply, premiums would be placed on engineers' services, and we know this is not the case at present.

Many of the men who took up the study of engineering because of the vision of fabulous salaries, induced by the reading of highly colored and exaggerated stories and advertisements, have found to their sorrow that the compensation does not meet up with the capital invested. They naturally are more pessimistic than they should be, and through their advice many students are persuaded not to take up engineering as a profession. Then, too, the natural reaction of untruthful advertising combines to cut down the registration of engineering colleges. The increased popularity of business and agricultural courses may be attracting some young men who might otherwise take up engineering, but it is more than likely that realization of the meager financial returns and lack of recognition of the engineering profession by the public is mainly operating to decrease the registration.

The situation may be alarming from the viewpoint of the colleges, but, even so, it has, in the writer's opinion, a silver lining. With the decrease in registration comes the chance to urge upon students the desirability of taking a longer and broader course, covering a period of five or six years, and thereby remedy the situation. This increased stay of a comparatively small percentage of students will keep up the quota and at the same time result in a more finished product, with a resulting elevation of the status of the junior engineer just out of college. Four years is not sufficient time for any thorough engineering course, and I believe this is more or less the general opinion among engineers; but when the colleges were crowded with students the natural desire was to turn out engineers as rapidly as possible to make room for the newcomers; and four years being the absolute minimum for satisfactory instruction, it was naturaly accepted as the most suitable period, all things being considered.

This seems to be a very opportune time to make a change in the length of engineering courses. Such a move will check the decrease in registration to a large extent and cut down on the oversupply of young engineers. The four-year courses should not be abandoned entirely, but they should be made the secondary rather than the primary courses and be limited to the stronger and more experienced students. Then the product of the longer and shorter courses would be more nearly uniform. The longer courses would relieve the menace of over-specialization which, no doubt, is the cause of many of the troubles of the profession.

In the past the desire of the engineering schools has been to train the students in a certain particular line as rapidly as possible and without including any more studies than are absolutely necessary for the completion of the purely technical training. Languages, literature, writing, public speaking, economics and business training have been pushed so far into the background in many cases that even if some or all of such studies were given they were so general, vague and poorly presented as to be a mere waste of time. As a result, the student detests these courses and avoids them whenever possible, since he can see no good in them. The result is the narrow-minded engineer, out of place in any company but that of his fellows.

The consensus of opinion now is that engineers must have a broader education if they are to take their proper places among members of the other learned professions. Doctors and lawyers are in general broad-minded men, since their preliminary education is of a broad character. The great majority in these professions graduate from a regular college course before entering the law or medical colleges. If such training makes men of these professions broader minded, more public spirited, and popular, can we rightfully deny that to supplement specialization in engineering schools with a broader general training, will not aid in solving the present problems confronting the engineering profession? Experience has shown that there is something fundamentally wrong in the engineering profession, and, taking all things into consideration, it seems that our educational system is somewhat at fault—too much specialization and hurry.

For the average high-school graduate, four years at college is not really enough, even for the required scientific studies. Some schools have recognized this fact for some time and are offering and planning five and six-year engineering courses; but it is difficult and slow work to overcome the momentum of the rapid-fire, hurry-up engineering education advocated by the majority. It is safe to say, however, that ere long the agitation among educators and engineers for a broader education of engineers will become so strong that the four-year courses will be practically discontinued.

From the standpoint of the practising engineer it is the writer's opinion that the field is somewhat overcrowded as a result of questionable advertising and publicity campaigns which were, and in a few cases are still, being waged. This overcrowding has had the tendency to curb the salary of engineers in general, for at present men can nearly always be found who, on account of circumstances, will work for much less than a rightful wage. The decrease in registration is the reaction caused by the general condition of under-pay and a demonstration of the natural law of equalization and tendency of things to preserve a certain balance or average. When the conditions of pay are improved there will no doubt be another increase, marked or gradual, in the engineering registration of colleges. Whether this will be sudden, with a resulting decrease in wages to preserve the balance, or gradual, without the attendant drop in remuneration, depends upon how the practising engineers and educators make use of the present lull. Let them get together and, in the light of their combined experience, work out the salvation of engineering as a profession now.

Chicago. ALBERT M. WOLF.

Fine and Coarse Aggregates

SIR: I read with much interest the article of Prof. Robert H. McNeilly in your issue of Nov. 26, 1915, page 659, the more so because at the time of its publication I was myself busy on a similar theoretical study of the most advantageous proportions of the coarse gravel aggregates. The conclusions reached are of course practically identical as to jump of sizes.

In view of Professor McNeilly's exhaustive and accurate study of the proportions of fine aggregates I would be very glad if you would encourage him to make a similar study of the effect of similar practice from the largest size aggregate down in the case of gravel or pebbles.

The application of the same theoretical principles used by Professor McNeilly in the proportioning of both coarse and fine aggregates promises to my mind the most important advance in the quality and economical manufacture of concrete that has been made in the last few years. I recognize that it is more reasonable to apply the same theory to round pebbles such as occur in gravels than to a coarse aggregate composed of crushed rock of angular formation.

I should be very glad to have you reconsider your editorial on Professor McNeilly's article published in your issue of Dec. 4, page 681. It seems to me that nothing is of more practical importance than the introduction of refinements in the proportioning of the materials that promise a remarkable improvement in the quality of concrete and at the same time a material reduction in its cost.

T. F. NICHOLS,
Office Engineer, Arizona Highway Department.
Phoenix, Ariz.

HINTS FOR THE CONTRACTOR

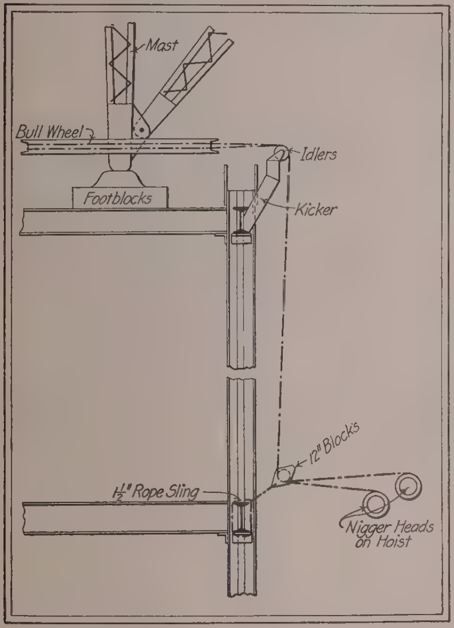
Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Bull-Wheel Adapted to Building-Erection Derricks

THE DRAWING published herewith shows how F. E. Warren, superintendent of construction for the George A. Fuller Company on the new Arcade Building in Pittsburgh, is successfully swinging the familiar steel-erection derrick with a bull-wheel. It has never been considered feasible to swing such derricks in any manner except by a hand lever, as they are raised, sometimes oftener than once a week, during the progress of erection, while the hoists which operate them remain on the ground. When one of these big derricks is handling a heavy load it is often so hard to swing that several men are required on the lever. By using ball bearings in the construction of some of the derricks on this job, only two men were at first required. Now, however, only one man, at the hoist below, is required, and loads can be swung much more quickly. It is estimated that 50 cents a ton is saved in the handling cost. The rig has been operated successfully on this building to a height of 210 ft., and could probably be used much higher. It is evident that the ordinary single-drum swinging engine could be used in the same way, winding the bight of a full coil of wire rope on the drum, carrying the ends to and around the bull-wheel, clamping them in the usual way, and lashing the two coils of surplus rope to the inside of the wheel. The cable would have to be paid out from above and readjusted on the bull-wheel, however, when the derrick was raised, which would take more time than is the case with the rig operated with nigger-heads.



BULL-WHEEL APPLIED TO ERECTION DERRICK

Concrete Reinforcing in Long Pipe Piles Lowered in Sections

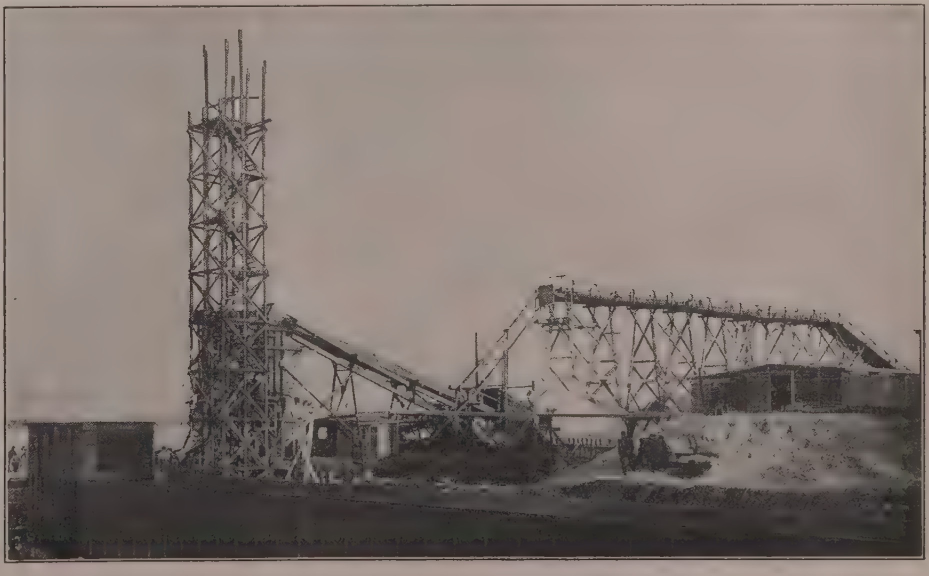
By ALEX. P. CRARY
Ancon, Canal Zone

FIFTY to sixty feet of reinforcing, composed of four vertical 1-in. square bars bound with $\frac{3}{8}$-in. hoops on 1-ft. centers had to be placed after driving in each of the 14-in. pipe piles for the quarantine landing stage at Balboa, Canal Zone, described in this section of the three preceding issues of the Engineering Record.

The units for each pile had to be built up by splicing individual bars. The length of bars mostly used was 24 ft., but as the joints had to be staggered, shorter pieces of various lengths were used in the bottom and the top of the sections. The bottom section was partly assembled on the platform and placed in the pile, being prevented from dropping by clips which caught on the top of the pipe. The part which projected above the pile was then further assembled. Next, at a point above the part last placed, the whole was gripped by clips and a tackle, raised so as to release the clips at the top of the pile and lowered until all of the assembled part was within the pipe. This process was repeated several times in placing each complete unit. The total weight of steel in each pile averaged 1000 lb., and it cost 67 cents per 100 lb. to place the reinforcing. The work was done by the writer as contractor under the direction of Rear Admiral H. H. Rousseau, engineer of terminal construction.

Conveyors Handle Materials Cheaply on Big Concrete Job

TEN THOUSAND yards of concrete materials may be stored, heated and rehandled to the mixer mechanically at low cost by the belt-conveyor layout illustrated in the accompanying photograph. This plant, installed by Barnett & Record, contractors of St. Paul, for building the new Milwaukee grain elevator of the Chicago & North Western Railroad, illustrates the growing appreciation of the saving to be made by handling the aggregate as well as the finished concrete mechanically. The upper conveyor, 350 ft. long and 40 ft. high delivers material to the storage pile. Under it in a gallery, fed by gates at frequent intervals, is the second Weller conveyor, which discharges material into a small bin from which it is drawn directly to the Milwaukee mixer. Inside the gallery of the lower conveyor are steam lines with coils every 16 ft., so that the sections of the pile from which the material is being drawn can be readily heated.



PLANT STORES AND HANDLES TEN THOUSAND YARDS OF AGGREGATE MECHANICALLY

Electric Lights and Heaters Cure Concrete

SMALL CAR heaters and banks of electric lights were used to maintain a hardening temperature on the concrete floor of the State Street viaduct, Chicago, repair of which was described in the Engineering Record for Jan. 1, 1916, on page 14.

Concrete was placed on the viaduct floor on Dec. 3 and 4, on which days the lowest temperature was 33 deg. Fahr. with a mean temperature ranging from 34 to 35 deg. On Dec. 5 the temperature dropped to 32 and on the 6th a heating system was installed. On the 6th, 7th and 8th the concrete was covered with heavy tar building paper and steam blown under this covering to supply the necessary warmth and moisture to hasten the hardening action. On the 10th electric heaters supplied with current from the trolley line were placed under the forms and enclosed with tar building paper to retain the heat generated. The fact that there was only 3 in. clearance between locomotive smoke stacks and the under side of the floor made it impossible to use any heating system that would necessitate considerable space for housing. The small car heaters, however, were of such dimensions as to fit under the bays between I-beams. Ten sets of heaters were used, but experiment showed that additional heat was necessary. Therefore, forty banks of five 32-candlepower, 120-volt incandescent lights were added to the heating equipment. The effect of this addition was very noticeable. The exposed surface of the floor was warm to the touch, light snow which fell upon it immediately melted and the moisture resulting from the melting snow evaporated quickly.

Although some of the floor was completed before the mean temperature had gone below 32 deg. Fahr., the last sections were placed during freezing weather, the last two panels being placed on Dec. 15. As it was desirable to resume traffic on Dec. 20, unusual precautions had to be taken to supply and maintain warmth that would insure the concrete attaining sufficient strength to permit street cars passing over the bridge.

FORMS CLEANED WITH STEAM

On the night of Dec. 14 the temperature was 8 deg. above zero but at 10 a. m., on the 15th, it had risen to 25 deg. Forms and steel members were in place coated with ice and snow and it required 1 hr. to melt the ice and warm up the steel with steam supplied through a 2-in. hose. Following this procedure forms were washed with clean, scalding hot water. At 11:15 a. m., Dec. 15, deposition of concrete was begun. Mixing water was heated by steam to 190 deg. Sand and gravel had previously been heated to a temperature of from 140 to 190 deg. Concrete came from the mixer at a temperature of 120 deg. Even after it had been in the forms for 15 min. the temperature ranged from 100 to 110 deg. At 11:30 a. m. the temperature of the air had risen to 31 deg. but by 1 p. m. had dropped to 27 deg. At 1:30 p. m. concrete that was first placed still had a temperature on the surface of 61 deg. At 5 p. m. the surface temperature of the concrete was at no place lower than 58 deg. Surface troweling was commenced at 5:30 p. m., and the job completed, heating apparatus installed, tarpaulins spread over the panels, and the workmen were on their way home by 9 p. m.

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HEATERS AND LAMP BANKS PUT IN BAYS BETWEEN BEAMS

The bridge repairs were carried out under the general direction of John Ericson, city engineer, and Thomas G. Pihlfedt, engineer of bridges and harbors, by the engineer in charge of bridge construction and repairs, F. H. Avery. H. J. McDargh, assistant engineer, had the work, which was carried on by day labor, immediately in charge.

Dynamite Proves Effective in Grubbing Reservoir Site

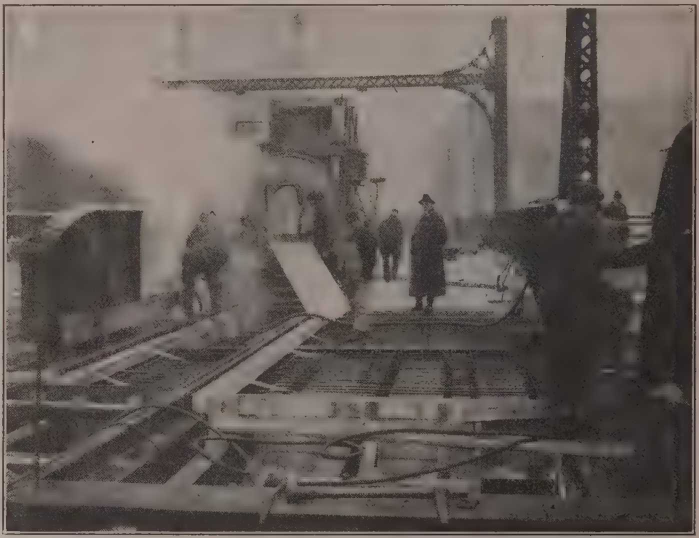
As a preliminary to admitting water to the Kensico reservoir of the Catskill water supply system for New York City the contractor was required to clear the site of the huge basin, which will flood 2218 acres of land, to a line 30 ft. outside of the flow line. How the work was done was described by George A. Winsor, section engineer of the Board of Water Supply, in a paper presented at the last convention of the New England Waterworks Association.

Under the specifications, grubbing included all designated areas within the 30-ft. margin of the reservoir, the reservoir bottom wherever the depth below the flow line is 35 ft. or less, and other areas wherever ordered. The grubbing consisted of the removal of all stumps and roots larger than 2 in. in diameter to a depth of 6 in. below the surface of the ground, and all holes left after grubbing the margins of the reservoir and its bottom to a depth of 10 ft. below the flow line had to be satisfactorily refilled. The principal natural timber growths around the basin consist of oak, maple, whitewood, birch, hickory, elm, locust, ash, dogwood, cedar, chestnut, and many fruit trees of different kinds. The chestnuts had been killed by the "bark disease."

Most of the clearing on the areas to be grubbed was done during the years 1910 and 1911, and the stumps of the trees were cut off close to the ground. For this reason the old method of pulling the stumps with a stump puller of capstan type, pulling the stump with the tree as a lever, using a block and fall, or the use of the caterpillar traction engine as used at Ashokan reservoir, were not adapted to the work at the Kensico reservoir.

The grubbing was sublet by the reservoir contractor, and a portion of it was again sublet. The method employed by the subcontractors was as follows: All small stumps from 2 in. to about 5 in. in diameter were grubbed by hand, using axes and mattocks, and all sprouts were cut off of the larger stumps, which were then removed with the aid of an explosive. Sixty per cent dynamite was used most of the time, the quantity depending upon the size of the stump, variety of tree, and the quality of soil around the roots. Many areas covered with a thick growth of small locusts were encountered; these were pulled with a pair of horses or yoke of oxen with a chain hitched around the tree; usually a little grubbing was done on one side only. This proved to be a very effective and rapid method for removing these species of trees when not too large.

The contractor usually worked about three weeks after a monthly estimate on the grubbing and blasting, as he found it required the remainder of the month to clean up and burn the brush and stumps before his next succeeding monthly estimate. Work was carried on through the winter months with very little interruption, it being a very mild winter with but little snow; during the spring months, which were very dry, the contractor was forbidden to build fires because of the fire hazard to city property adjacent to the clearing limits. He continued with the grubbing operations and burned the stumps later when the grass was green and the weather suitable.



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USING LIVE STEAM TO CLEAN ICE FROM FORMS AND STEELWORK

A daily record of the dynamite used was kept by the contractors for the estimate months, and the quantities used per acre have been computed as follows: Maximum dynamite used, September, 1914, 170 lb. per acre; minimum dynamite used, January, 1915, 44 lb. per acre; average dynamite used, for entire work, 95 lb. per acre.

It was further demonstrated that it required less explosive to shatter a stump when the ground was frozen than when there was no frost. In the former case very little earth was disturbed by the blast; while in the latter case a large hole was made. A hole was made in the ground with an iron bar, and the explosive was placed under the stump; fuse exploders were always used.

The contract price for grubbing, which included refilling holes, disposing of stumps and brush, and all expenses incidental to the work, was $100 per acre. Mr. Winsor believes that the method employed in doing this work was the most economical and the best, under the circumstances. However, had it been possible to do the clearing and grubbing in one operation, the latter would have cost the contractor less, as there would be a considerable saving in both labor and explosive if one of the other mentioned methods had been employed.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Expect to Begin First Unit of Cleveland Subway by Early Spring

Euclid Avenue Line, 4.4 Miles Long, Will Probably Cost $4,840,000—Removal of Water Connections Already Begun

Actual construction work on Cleveland's first passenger subway—a double barrelled tube under the 4.4 miles of Euclid Avenue between University Circle and the Public Square—is promised by early spring by the Cleveland Rapid Transit Railway. The city waterworks, at the request of the company, began Jan. 8 the removing of water connections in Euclid Avenue between East Seventy-first and Seventy-fifth Streets. The city engineers have approved the plans of typical cross-sections and stations. The company officials state that they are ready to let the general contract to a New York firm as soon as final details of financial backing are closed. The total to be expended on the tubes, exclusive of rolling stock, station embellishments and the Public Square terminal, is estimated at $4,840,000.

Plans which have received the city's approval call for a double-barrelled reinforced-concrete subway. Each barrel will have inside dimensions of 10 ft. 4 in. by 12 ft. 6 in. Overall dimensions of both barrels, which will be contiguous, are 25 ft. wide by 16 ft. high. The open-trench type of construction will be used, and at all points the sand-crushed stone foundation of the Euclid Avenue paving will rest directly on the subway roof.

The rapid transit company's franchise reads: "Actual construction work or the removal of obstructions shall be begun within twelve months (Jan. 23 is the expiration date), and at least one double-track line from the Public Square to the city limits shall be completed and in operation within thirty months after such construction is begun. After the completion of the first line at least 5 miles of double-track line shall be completed in the next succeeding period of three years, and thereafter at the rate of not less than 5 miles in each succeeding three years. At the end of the first year of construction at least $500,000 shall have been expended, and by the end of the second year at least $1,500,000." The rapid transit company's franchise gives it the right to dig subways under every important street in Cleveland, and to locate its downtown terminal under the Public Square. It is expected that the quicksand that underlies much of Cleveland's downtown section will present unusual difficulties.

Designs for the Euclid Avenue tubes have been prepared by the W. S. Ferguson Company, of Cleveland. Traffic data compiled by Ford, Bacon & Davis, of New York, led to the decision to construct the Euclid Avenue line first. The estimated cost per single-track mile of the first subway is $550,000.

Robert Ridgway Named for Chicago Traction Commission

Robert Ridgway, engineer of subway construction of the New York Public Service Commission, has been named by the sub-committee of the Chicago local transportation committee of the City Council as the third member of the Chicago Traction Commission.

Ferris Water Power Bill Passed

The House of Representatives passed the Ferris water power bill, Jan. 8.

Water Main Breaks Shut Off Supply of Section of Seattle

The entire southern portion of the city of Seattle, Wash., was shut off from its water supply by a series of breaks that occurred Jan. 11 in a 51½-in. wood-stave main leading from the intake to the city. Three breaks occurred within a ½-mile radius, uncovering from 200 to 300 ft. of the line. A proposition to build a permanent aqueduct of concrete and steel to replace the damaged line has been indorsed by Mayor Gill of the city, Superintendent of Waterworks Youngs, and City Engineer Dimock.

Supreme Court Decides Oregon Highway Engineer Controversy

The controversy which has been waged for the last 6 months over the supervision of the Oregon State Highway Department was settled Dec. 28 when the Supreme Court of that state handed down an opinion written by Justice Bean. This opinion declares that State Engineer Lewis is in reality in charge of the state road work instead of E. I. Cantine, chief deputy engineer. The decision was rendered in mandamus proceedings instituted by Petersen & Johnson, contractors.

In allowing the application for the writ the court construed the measure passed by the last Legislature consolidating the state highway department with the office of the state engineer, to make invalid the provision which placed the state highway work in charge of a chief deputy engineer. The court held that this provision conflicted with the title of the act.

Start Work on 87-Mile Pipe Line

The Prairie Pipe Line Company of Independence, Kan., has started the laying of an 87-mile pipe line from the Augusta oil field to the company's tank farm at Neodesna. From the latter point the Standard Oil Company will pipe the oil to New Jersey.

State Commissions' Valuation Views to Be Discussed Jan. 26

Wednesday, Jan. 26, has been set by the Interstate Commerce Commission for the oral discussion of the briefs on valuation filed by the National Association of Railway Commissioners and by the several state commissions. These are in answer to the brief presented by the railroads at the conference of Sept. 30 and Oct. 1, 1915. Excerpts from the brief of the Minnesota Railroad and Warehouse Commission appeared in the Engineering Record of Jan. 1, page 12, and editorial comments thereon in the issue of Jan. 8, page 36. Briefs have also been filed by the state commissions of California, Kansas and Oregon.

Move Toward Merging of Chicago Railway Terminals

Another step was taken in Chicago Jan. 10 toward the merging of railway terminals for roads entering from the south, when the City Council took up a resolution calling for consultation with the Illinois Central Railroad over suggested terminals either at Twelfth Street or at Randolph Street, the station to have sufficient capacity to accommodate the roads now terminating at the LaSalle Street, the Dearborn and the Grand Central stations. Electrification is one of the questions to be decided.

Will Help American Contractors in Handling Work in Foreign Fields

Willard Straight Points Out Opportunities Opened to Constructors by American International Corporation

The American International Corporation, the $50,000,000 company organized recently for the exploitation of foreign trade, stands ready to aid American contracting organizations which undertake work abroad to the extent of taking over and floating the securities which the contractor must take in payment. This point was strongly emphasized by Willard Straight, formerly of J. P. Morgan & Company, and now vice-president of the new corporation, in an interview with a representative of the Engineering Record early last week. Mr. Straight pointed out that in the past no matter how competent a contracting company might be, so far as the actual execution of work was concerned, it had no future in the foreign field unless it were able to dispose of the bonds taken in payment for the work. Save in unusual cases this could not be done and American firms, therefore, with few exceptions, have been obliged to refrain from taking contracts abroad. This obstacle the American International Corporation is now prepared to overcome.

Object of Corporation

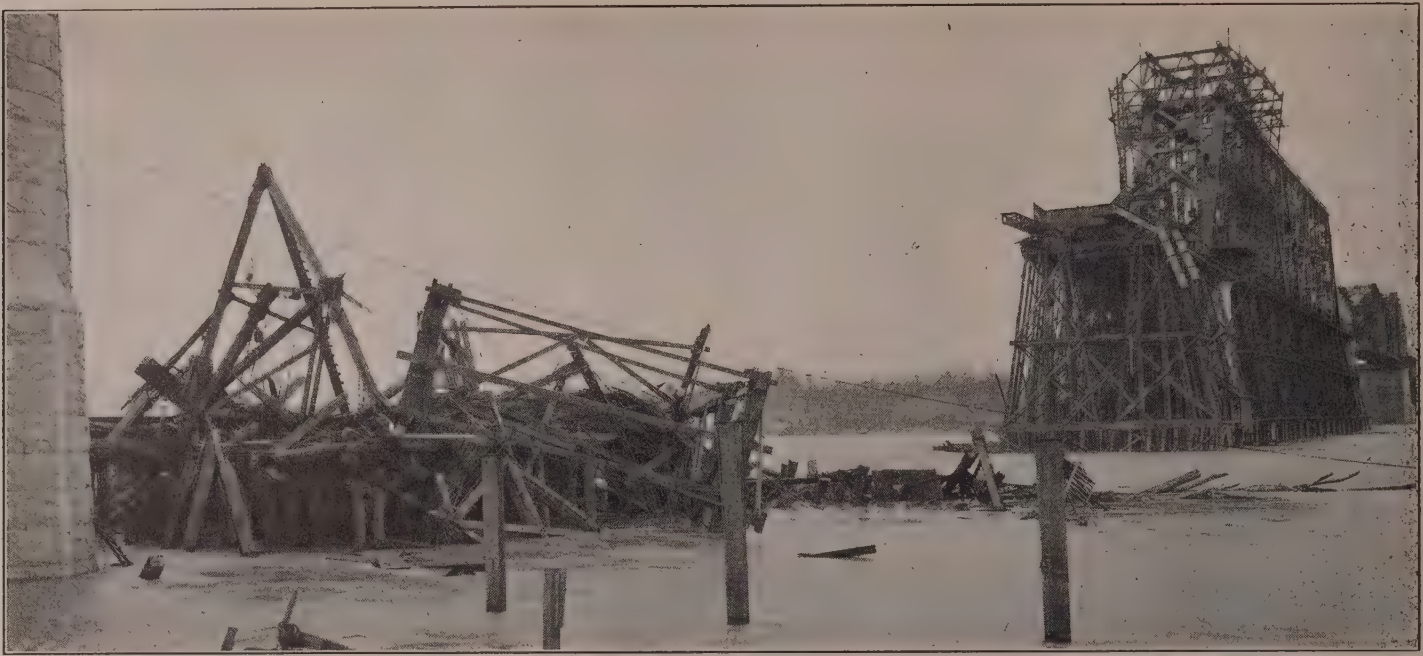
"The new corporation," said Mr. Straight, "was organized for the purpose not only of aiding in the opening of the foreign field to American investment, but of developing new outlets for American commerce and enterprise of every kind. Naturally, it desires to have American contractors execute the works for which it handles the securities.

"It is manifest, of course, that this is not an opportunity for the inexperienced or unstable contracting company. There are difficulties out of the ordinary in handling large works at a distance and the American International Corporation will not be disposed to lend assistance unless the organizations have the necessary technical ability and financial resources. Each proposition will be carefully investigated by the new corporation, and when the credit of the issuing country or municipality is satisfactory and the contractor has the required financial standing and technical ability, the corporation will be prepared to take the bonds and relieve the contractor of the burden of their disposal."

Investigation Needed

Questioned as to his views of the possibilities in other countries, Mr. Straight replied that they were very large. He made it plain, though, that work is not going begging, and that it is not to be had by anyone merely because under sudden enthusiasm he resolves to go into foreign fields. Careful investigation of those fields is necessary by anyone contemplating entry into them, and that investigation must be made by someone thoroughly competent to appraise conditions from the contractor's viewpoint and especially as to the labor situation. "Though not absolutely necessary," said Mr. Straight in discussing investigations in South America, "a knowledge of Spanish is desirable for all countries except Brazil. There Portuguese is the national tongue. As an alternative to Spanish and Portuguese, French would be preferable to English, since practically all South Americans of position speak French."

Asked as to the countries in which the op-



MEMPHIS BRIDGE FALSEWORK FAILURE AND WRECKAGE OF GANTRY TRAVELER, NOTED IN LAST WEEK'S ISSUE
Photograph by C. H. Poland furnished by A. L. Dabney of the Dabney Engineering Company, Memphis, Tenn.

portunities are greatest, Mr. Straight pointed out that the most immediate field is South America, since it is at peace. There are great opportunities, however, in Russia, while China deserves careful consideration.

Foreign Contracts as a Stabilizer

"Viewing the question broadly," Mr. Straight said by way of conclusion, "the foreign field offers to the American contractor the same advantage which export trade offers the manufacturer—the stabilization of his business by diversification of his outlets. It spreads his risk, and he is more certain of normal business than if all his activities are confined to one country. Manifestly, though, it is only the organization of some size that can command sufficient resources to operate on a goodly scale both here and abroad."

Division Street Bridge Failure in Spokane Due to Poor Material?

Supplementing the engineers' report printed, in part, on page 29 of the Engineering Record of Jan. 1, and the photographs of the wrecked structure on page 62 of last week's issue, in connection with the Division Street bridge failure in Spokane, Wash., another report has just been made which contains the statement that the material in the eyebars which failed was inferior at the time the bridge was built, and would probably have been rejected under careful engineering inspection. This report was made to the coroner of Spokane County by John W. Cunningham, of Boar & Cunningham, civil engineers, of Portland, Ore.

Examination of the eyebars indicates a poor grade of steel, according to the report. Mr. Cunningham says further: "I understand that crystallization has been blamed for the failure. It is my opinion, based upon some of the best authorities, that there is no change in the crystalline form of steel after it is cooled. There is, however, a progressive weakening of metal under repeated stresses, which is known as fatigue. Fatigue is caused by a gradual spreading of microscopic flaws and cracks, and occurs when the metal is stressed close to the elastic limit. Fatigue occurs with the best grade of steel, but is most evident with poor quality."

Three causes of failure are stated: First, the condition of the material, aggravated by fatigue; second, the fact that at the time of failure the bridge was loaded to give maximum stress conditions in these end lower chords—possibly this was the first time that two cars had passed at this point since the creosoted block pavement had been laid and, third, the low temperature at the time of failure—16 deg. Fahr. The end shoe apparently did not allow for expansion and contraction, hence the low temperature would produce a definite additional tensile stress, which with the existing tension may have made a large total.

Cincinnati Preliminary Rapid-Transit Plans Near Completion

The Cincinnati Rapid Transit Commission expects to complete all preliminary plans for the city's proposed rapid-transit system in time so that the question of issuing the $6,000,000 worth of bonds needed to finance the construction may be submitted to a popular vote in April. Prof. George F. Swain, of Harvard University, who made the original survey, and who, together with Prof. Ward Baldwin, of Cincinnati, has been retained as consulting engineer by the city, met with the commission Jan. 8 and 9 to go over certain modifications of the original plans. Professor Swain announced himself as satisfied with the scheme in general as tentatively selected by the commission.

The project is to serve the double purpose of a rapid-transit loop connecting the city's various hilltop suburbs, and an entrance for interurban lines, all of which now have their termini on the outskirts of the city. One of the present problems facing the commission is that of getting these interurban lines to establish connections at convenient points with the loop system. Frank S. Krug, city engineer, and chief engineer of the commission, is at present negotiating with the officials of these lines on this matter.

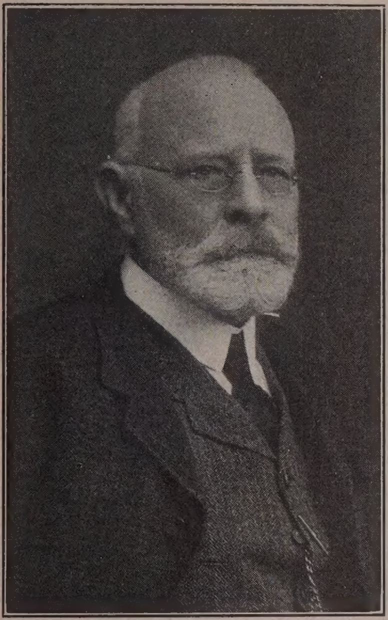
Rapid Tunnel Progress

During the past calendar year 3.5 miles of heading and 2.8 miles of double-track tunnel enlargement were completed at the Rogers Pass Tunnel of the Canadian Pacific Railway at Glacier, B. C. The heading has been completed, as noted on page 29 of the Engineering Record for Jan. 1, 1916. The double-track enlargement is now progressing at an average rate of somewhat more than 50 ft. per day.

STEAM SHOVEL AVERAGES 50 FEET A DAY IN ENLARGING ROGERS PASS TUNNEL

C. C. Schneider, Eminent Bridge Engineer, Dead

Bridge Engineer Whose Professional Attainments Were Recognized by Many Honors



CHARLES CONRAD SCHNEIDER

Charles Conrad Schneider, eminent bridge engineer, past-president of the American Society of Civil Engineers, and for the past 14 years consulting engineer of the American Bridge Company died at his home in Philadelphia Jan. 8. He was 72 years old and during his professional career had been the recipient of many high honors. He was appointed a member of the Quebec Bridge Commission, which investigated the failure of the old Quebec bridge in 1907, and of the later commission appointed in 1911 by the Canadian government to supervise the construction of the new bridge. He was awarded the Rowland prize and the Norman medals by the American Society of Civil Engineers for excellent papers on his design of the Niagara cantilever bridge (1886), on structural design of buildings (1905), and on movable bridges (1908).

As a concrete instance of the almost universal regard for Mr. Schneider's sense of fair play, it is related that in one case of a disagreement between the general contractor and the sub-contractor, at the time when Mr. Schneider was consulting engineer for the latter, the general contractor voluntarily agreed to accept his decision with regard to a disputed point involving a considerable sum. Mr. Schneider, further, had an exceptional intuitive sense of the right way to accomplish results, not only in general design problems, but in the sometimes more difficult questions of detail, and his advanced methods were widely disseminated through younger associates.

It is probable that Mr. Schneider was largely responsible for the pound-price method of letting contracts, now so largely superseding the lump sum basis. His specifications for bridges and buildings, used for years at the Pencoyd Iron Works, was a forerunner of many of the more important provisions, such as impact and allowable stresses, in the American Railway Engineering Association specifications now so widely adopted.

Mr. Schneider was born in Saxony, Germany, in 1843, and graduated as a mechanical engineer from the Royal School of Technology at Chemnitz in 1864. He married in Paterson, N. J., in 1880. After machine-shop practice in Germany, and drafting work with the Rogers Locomotive Works in Paterson, he became assistant engineer with the Michigan Bridge Company of Detroit, and later engineer with the Erie Railroad Company. In 1876 he worked with engineers of the Long Island Bridge Company on a proposed design for a Blackwell's Island bridge. He was designer for the Delaware Bridge Company, New York City, and then for eight years in consulting practice in that city when he designed several long span bridges, among them the Fraser River cantilever bridge for the Canadian Pacific Railway in 1882 and the Niagara cantilever bridge in 1883.

He was called as chief engineer to the bridge and construction department of the Pencoyd Iron Works, Philadelphia, in 1886, and became vice-president for the American Bridge Company, in charge of engineering, in 1900. Since 1901 he has been consulting engineer for that company, with outside practice in Philadelphia. During this time he has acted on the Quebec Bridge Commissions already referred to, and has been consulting engineer for the Canadian Pacific Railway. He designed, with F. B. Kunz, the Reversible Falls steel arch bridge at St. John, N. B., and was consulting engineer until its completion in 1915.

He was a member of the American Society of Civil Engineers, the American Railway Engineering Association, the American Society for Testing Materials, the Verein Deutscher Ingenieure of Berlin, and the Engineers' Club of New York. He was the author of General Specifications for Railroad Bridges (1886), for Highway Bridges (1901), and for Structural Steel Work in Buildings (1905). A more complete article on his work and influence as one of the most eminent bridge engineers in this country will be found in the Engineering Record of Sept. 12, 1903, page 315.

Smoke Prevention Campaign in Cincinnati Progressing

Charles W. Heath, city smoke inspector of Cincinnati, has induced the railroads entering that city to equip 304 locomotives with satisfactory smoke prevention devices. Eighteen months ago, when the campaign was started, not a single locomotive in the city was equipped with any such device. By Jan. 1, 1915, successful installations had been made on 99 locomotives since when 205 additional installations have been made. The list includes practically all of the switch engines and local freight locomotives operating in the city.

Nominate American Concrete Institute Officers

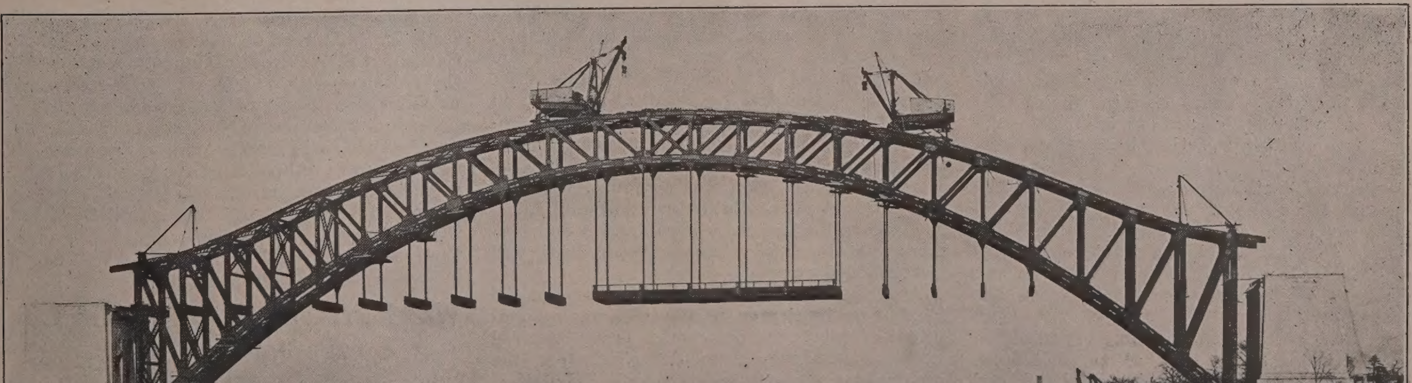
The following nominations have been made for offices to be filled in the American Concrete Institute at the election to be held this winter: President, Leonard C. Wason; vice-president, Henry C. Turner; treasurer, Robert W. Leslie; directors, Charles R. Gow, Edward D. Boyer and J. G. Treanor.

Pasadena Decides on Sewage Disposal Plant

Plans have been completed for the installation of a sewage disposal system which will handle the combined sewage of the cities of Alhambra, Pasadena and South Pasadena, the total population of which is 60,000 at the present time, with an estimated increase in thirty-five years to about 250,000.

The sewage disposal farm laid out by the Tri-City committee is located near the city of Alhambra and consists of nearly 600 acres of partially hilly and partially level land. The

Suspended Floor System on Hell Gate Bridge Is Nearly Completed



IT IS ESTIMATED THAT THE BRIDGE WILL BE OPEN FOR TRAFFIC EARLY IN 1917—17,500 TONS OF TOTAL OF 19,500 TONS IN PLACE JAN. 3

proposed sewage disposal works are located on the south slope of the roughest part of the area at a point where the topographical features are such that there is the least likelihood of any nuisance from odors. As an additional safeguard against odors an extensive grove of eucalyptus trees is to be set out on that part of the area adjacent to the disposal works.

A 48-in. outfall sewer conveying the combined sewage of the three cities will deliver sewage through a Venturi meter to a battery of six Imhoff tanks. After the solids have been separated from the sewage in these tanks, the effluent will be delivered to sprinkling filters covering 3 acres of ground where the clarified sewage will be further purified. From the sprinkling filters the liquid will pass through a secondary tank in which any particles still held in suspension will be removed. If found necessary, a chlorination plant will be added to further purify the effluent. From this last stage of the treatment the water will be used for irrigating purposes and is expected to be pure enough to insure safety for any desired agricultural use.

The Tri-City committee consists of R. V. Orbison, city engineer of Pasadena, president; Charles E. Hewes, city engineer of Alhambra, secretary, and John MacMillan, city engineer of South Pasadena.

Second Pan-American Scientific Congress Terminates Sessions

The Second Pan-American Scientific Congress came to an end in Washington, Jan. 8, after sessions which lasted two weeks and which were participated in by delegates officially sent to Washington by the governments of twenty American republics in addition to those of the United States. The First Congress was held in Santiago, Chile, in 1908, and the second was held in Washington, because of the changed conditions brought about by the war in Europe, and the desire for closer co-operation between the American republics as a result of the war, which was given its first official impetus at the Pan-American Financial Conference held in Washington last May.

While many of the newspapers of the country, in their reports of the proceedings of the Second Pan-American Scientific Congress have paid principal attention to the political aspect of the Congress, and its object of drawing the American republics closer in spirit, as a result of the war, and to the hope of a trade stimulation between the countries of this hemisphere, again due to the war, the fact is that many questions of scientific interest were taken up by the delegates to the Congress, in engineering, electrical, metallurgical, chemical and transportation fields. The foremost men in South and Central America were sent to Washington by their respective governments to discuss these questions with men equally prominent in these lines in the United States, and in addition there were a number of unofficial delegates from Latin America attending the Congress. There were 81 official delegates from Latin America, 46 unofficial delegates, representing societies, institutions, etc., and, in addition, 53 members of the Congress, who went to Washington as the guests of the Carnegie Endowment. Many of these Latin Americans were accompanied by the members of their families, making a total representation of 299. In addition, there were about 800 delegates, official and unofficial, from the United States.

The work of the Congress was organized in sections, there being nine of these groups. They met in various Washington hotel and other auditoriums, including the New National Museum, the Carnegie Endowment Building, the Pan-American Building and in other places, and the section meetings continued simultaneously. The United States Government appropriated $85,000 for the expense of the Congress, and each of the governments of other countries appropriated large sums, the Argentine delegation having been allowed $90,000 for its expenses. Fifteen national and international societies also held conventions in Washington in connection with the Congress, meeting in joint session with the sections of the Congress in whose work they were particularly interested.

Questions of interest to the engineering profession were taken up in Section III, devoted to the conservation of natural resources, of which Dr. George M. Rommel, of the United States Department of Agriculture, was chairman, and in Section IV, devoted to engineering, of which Brig.-Gen. W. H. Bixby, U. S. A., retired, was chairman. Questions of interest to the metallurgical and chemical industries were also taken up in Section III and Section IV, and in Section VII, devoted to mining, metallurgy, economic geology and applied chemistry, of which Hennen Jennings, former president of the London Institute of Mining and Metallurgy, was chairman. Questions of interest to the electric railway field were taken up in Section IX, devoted to transportation, commerce, finance and taxation, of which Dr. Leo S. Rowe, of the University of Pennsylvania, was chairman.

Among the papers of engineering interest were: "Scientific Work of the U. S. Office of Public Roads," by L. W. Page, director of the U. S. Office of Public Roads and Rural Engineering; "Municipal Water Supply," by Prof. George C. Whipple, Harvard School of Engineering; "Reservoirs for Municipal Water Supply," by Alfred D. Flinn, deputy chief engineer, Board of Water Supply, New York City; "Vertical Lift Bridges," by J. A. L. Waddell, consulting engineer, Kansas City; "Contracting and Regulating Works at the Mouths of Rivers," by Dr. E. L. Corthell; "Engineering Work of the U. S. Reclamation Service," by A. P. Davis, director of the U. S. Reclamation Service; "Best Type of Construction for Piers and Quays on Water Fronts of Great Depths and Swift Currents," by J. F. Coleman, New Orleans; "Final Disposition of City Sewage," by Rudolph Hering; "Disposal of Sewage and Garbage," by Morris Knowles, consulting engineer, Pittsburgh; "Sandy Seacoast Shore Protection," by B. F. Cresson, Jr., New Jersey State Board of Commerce and Navigation, and "Uniform Gage for Railways in Pan-America," by Fred Lavis, consulting engineer, New York City.

Work on Government's Alaskan Railway Up to Schedule

The close of the construction season found work on the railway under construction by the government in Alaska up to schedule. Grading, so the chairman of the commission states, has been completed for 35 miles, from Anchorage, the base on Cook's Inlet, to Mantanuska Junction, and rail has been laid for 14 miles. Winter work will be confined to some rock excavation and a small amount of track laying.

During the next construction season, the line will be pushed eastward from Mantanuska Junction to the coal fields—a distance of 40 miles, through very rough country. The connecting line from Anchorage southward to the head of the Alaska Northern Railway, at Kern Creek, a distance of 35 miles, will also be built next year. So far as additional funds then allow, the line from Mantanuska Junction northward to Fairbanks, via Broad Pass, will be pushed forward.

At present the base town, Anchorage, at the head of navigation on Cook's Inlet, has a population of 1500. Reports which have appeared in some newspapers, to the effect that the inhabitants were threatened with starvation, because of the difficulty of getting in supply boats, are absolutely without foundation. The commission has two storehouses filled with provisions while the merchants are fully stocked.

This winter Lieut. Frederick Mears is in charge in Alaska, while the two other members of the commission, William C. Edes, chairman, and Thomas Riggs, Jr., are in Washington.

Engineers Honor Henry W. Hodge at Luncheon

Praise Appointment of Engineer to Public Service Commission in Charge of Utilities of New York City

Professional associates and friends of Henry W. Hodge, who was recently appointed a member of the Public Service Commission of the First District, New York, tendered him a luncheon at the Railroad Club, Jan. 12. In an informal address the chairman, William J. Wilgus, consulting engineer, formerly vice-president and chief engineer of the New York Central & Hudson River Railroad, emphasized the importance of the appointment of Mr. Hodge from the standpoints of the public and of the profession. His specialized knowledge, Mr. Wilgus believed, would be invaluable to the public in the interpretation of engineering matters which he can make to his fellow members of the commission. That interpretation will have the more attention when coming from a member of the commission than if it should come from an engineer in subordinate capacity. With these sentiments, Mr. Wilgus and succeeding speakers joined most heartfelt congratulations to Mr. Hodge on his appointment, together with pledges of the earnest support of the profession. Lewis B. Stillwell, past president of the American Institute of Electrical Engineers, pointed out a practical direction in which Mr. Hodge's professional brethren might aid. They could come to the defense of positions he might take when such positions were misinterpreted in the newspapers and unfairly attacked.

Replying to the felicitations, Mr. Hodge said that for personal reasons he preferred not to accept the position. He had yielded, however, as a matter of duty to the profession, since engineers had long urged the advisability of having engineers on such bodies. He declared that already many engineering problems had arisen, in his brief membership on the commission, with which his professional work had never brought him in contact. The advantage he possessed in considering them was that he could always pick specialists who could by a mere suggestion guide him correctly or, if need be, make a thorough study of the problem. He promised to avail himself of the proffers of assistance for guidance in the difficult technical matters that might arise.

In addition to those already mentioned the following made brief remarks: Gustave Lindenthal, consulting engineer for the Hell Gate and other large bridges; C. O. Moilloux, past president of the American Institute of Electrical Engineers; E. W. Stern, chief engineer of highways, Borough of Manhattan, New York; Lincoln Bush, former chief engineer of the Delaware, Lackawanna & Western Railroad; E. S. Jarrett, consulting engineer; E. P. Casey and C. W. Leavitt, consulting engineers; C. W. Baker, editor of *Engineering News*, and E. J. Mehren, editor of Engineering Record.

Among those present were also F. A. Molitor, who was in charge of arrangements for the luncheon; Allen Hazen, Colin M. Ingersoll, Rudolph P. Miller, Henry B. Seaman, Mason R. Strong, O. E. Hovey, Emil Diebitsch, P. W. Henry, E. P. Goodrich, James B. French, P. H. Ashmead, and T. Kennard Thomson.

Wood Preservers to Meet in Chicago January 18-20

Interest in the twelfth annual convention of the American Wood Preservers' Association, to be held at the Hotel Sherman, Chicago, Jan. 18-20, is enhanced by the effect of the European war on the supply of creosote oil. Two of the papers will be on the foreign creosote-oil situation and the zinc-chloride situation, by G. A. Lembcke and William Townsley, Jr., respectively.

Other papers to be presented include "Fungi Which Grow on Untreated Ties," by Dr. Hermann von Schrenk; "Woods Suitable for Crossties," by R. Van Metre; "Wood-Block Flooring," by Clyde H. Teesdale; "Methods of Creosoting Douglas Fir Timbers," by O. P. M. Goss, and "Creosote Piling and Poles," by Frank W. Cherrington. The standing committees on preservatives, specifications, wood-block paving and plant operation, those on service tests of crossties, wood-block paving and bridge and structural timber, and the special committee on specifications for preservatives for wood paving blocks will also report.

A banquet will be held Wednesday evening, Jan. 19, at which Prof. F. H. Newell, head of the Department of Civil Engineering at the University of Illinois, and at one time secretary of the American Forestry Association, will be the guest of honor.

Western Society of Engineers Holds Annual Dinner

Samuel Insull, president of the Commonwealth Edison Company, Chicago, made the main address at the annual dinner of the Western Society of Engineers, Jan. 12. His subject was "Universal Electric Supply." If all energy requirements in the United States could be supplied from one system of production and distribution, the diversity of demand is such that the present 43,000,000 hp. required could be reduced to 30,000,000 hp. The saving would be 250,000,000 tons of coal per year. A universal system of electric supply, in Mr. Insull's opinion, is as inevitable as day or night.

W. B. Jackson, the outgoing president, in his address discussed the ethics of the profession, and announced that John W. Alvord had given the society $1,000 without restrictions to provide funds for a medal to reward men who have performed great and inconspicuous service to the engineering profession, particularly in connection with public works.

B. E. Grant, the newly elected president, spoke briefly on the problems of the society and the visible means of overcoming them. How to increase the membership, possibly by the Philadelphia method, and how to meet the needs of the younger members and to get more men working were topics discussed.

The Chanute medals were awarded to Andrews Allen, consulting engineer, for the best general engineering paper on "The Engineering Opportunities of our Coal Mining Fields," to N. M. Stineman for the best civil engineering paper on "Reactions in a Three-Legged Stiff Frame with Hinged Column Bases," and to H. E. Goldberg for a mechanical engineering paper on "Arithmetical Machines."

Dr. Edwin H. Lewis, dean of Lewis Institute, gave a rapid fire presentation to each speaker. He also had a chance to characterize the past presidents of the society as their youthful pictures were thrown on the screen.

The officers elected to head the society for 1916 are as follows: President, B. E. Grant, division engineer, Board of Local Improvements, city of Chicago; first vice-president, C. H. Cartlidge, bridge engineer, Chicago, Burlington & Quincy; second vice-president, D. W. Roper, assistant chief operating engineer, Commonwealth Edison Company; third vice-president, Prof. F. H. Newell; trustee, Ernest McCullough, consulting engineer.

To Form Waterworks Section

To organize the "Four State Section" of the American Waterworks Association members from Delaware, Maryland, southern New Jersey and eastern Pennsylvania are invited to attend a meeting to be held at the Bellevue-Stratford Hotel in Philadelphia, Jan. 18; luncheon will be served at 12.30 p. m. The organization committee consists of N. Emory Bartlett, W. H. Boardman, Carleton E. Davis and Charles R. Wood.

New Water Supply at Wellington, Kan.

The new water supply at Wellington, Kans., that provides water from underground sources, 14 miles from the city, has been completed.

Personal Notes

BERTRAND E. GRANT, division engineer, Chicago Board of Local Improvements, who was elected president of the Western Society of Engineers in the three-cornered campaign ending Jan. 7, has been an active member of the society for twenty-five years. Graduated from Rensselaer Polytechnic Institute in 1890, at the age of twenty-two years he went directly to Chicago to work with L. E. Cooley on the first Drainage Canal engineering corps. This work was soon stopped, and Mr. Grant spent a year as assistant city engineer in Waterbury, Conn. In 1892 the Drainage Canal work was resumed, and he returned to Chicago and was for six years on its engineering staff. Following this he was resident engineer on the Snoqualmie Power Company work as the personal representative of T. T. Johnson, consulting engineer. The field of the consulting structural engineer claimed his attention from 1890 to 1905. In the latter year he entered the service of the Chicago local improvements board. His first work in this connection was the original design of the so-called Michigan Boulevard Link. He was then given charge of sewers and sewage pumping stations in the southern sandy section of the city.

New President of Western Society of Engineers

BERTRAND E. GRANT

DANIEL C. HAYNE, assistant city civil engineer of Indianapolis, has been assigned by B. J. T. Jeup, city engineer, to have charge of the engineering department of the Indianapolis Board of Park Commissioners.

E. B. HILLEGASS, formerly assistant engineer of the Atlantic Coast Line Railroad at Rocky Mount, N. C., has been appointed engineer of roadway at Savannah, Ga., succeeding C. J. Chenworth, whose promotion to another office is noted elsewhere in these columns.

W. B. KESTER, formerly assistant engineer of the St. Louis division of the Vandalia Railroad, has been appointed assistant division engineer, succeeding R. T. Simpson, whose appointment to another position is noted elsewhere in these columns.

JAMES R. STEELE, JR., formerly connected with the New York State Board of Tax Commissioners, has been appointed appraiser in the real estate department of the Pennsylvania Railroad. Mr. Steele received his professional education at Rensselaer Polytechnic Institute, and was engaged in business as a road contractor in New York State, previous to entering the service of the tax commissioners.

R. T. SIMPSON, formerly assistant division engineer on the St. Louis division of the Vandalia Railroad at Terre Haute, Ind., has been appointed assistant engineer on the Western division of the Pennsylvania.

SAMUEL G. BENNET has resigned from the office of city engineer of Oxnard, Cal., to accept appointment as field engineer for the Ventura County (Cal.) Highway Commission. Mr. Bennet first engaged in engineering work in 1886 as chainman for E. T. Wright. In 1890 he was appointed assistant engineer for the Redondo Railway Company and, in 1896, he became engineer for the Chicala Water Company at Rialto, Cal. Previous to his appointment as city engineer of Oxnard, he also served as assistant resident hydrographer in California for the U. S. Geological Survey and as engineer in the U. S. Reclamation Service.

MAJOR-GENERAL WILLIAM C. GORGAS received the Geographic Society of Chicago gold medal for his work in the Panama Canal Zone, Jan. 8, and addressed the Society on "Sanitation in its Relation to Geography." The honor conferred on General Gorgas has been conferred on but two occasions previously, once to Captain Roald Amundsen for the discovery of the South Pole, and, the second time, to Major-General George W. Goethals for the construction of the Panama Canal. While in Chicago General Gorgas also spoke on "Sanitation and Single Tax" at a banquet given in his honor Jan. 10 by the Chicago Single Tax Club, the Chicago Medical Society, the Illinois Manufacturers' Association, the Chicago Dental Society, the Lawyers' Association of Illinois, the Women's City Club, the American Chemical Society, the Medical Reserve Corps of the U. S. Army and the Illinois National Guard.

I. J. STANDER, formerly connected with the Department of Docks and Ferries of New York City, has organized the firm of I. J. Stander & Company, Inc., 118 East Twenty-eighth Street, New York City, to conduct an engineering and contracting business, with special reference to the construction of bulkhead walls, piers, docks, and submarine and heavy foundation work. Mr. Stander was connected with the Department of Docks & Ferries for about sixteen years.

CHESTER E. ALBRIGHT, consulting engineer, of Philadelphia, has been appointed chief engineer of the Bureau of Surveys of the Department of Public Works of that city, succeeding George S. Webster, whose appointment as director of the Department of Wharves, Docks and Ferries of the city was noted on page 771 of the Dec. 18, 1915, issue of this journal. Mr. Albright was graduated from Lafayette College in 1883, and has been engaged in engineering work since that time. For twenty-five years he was engaged in private practice in Philadelphia. Among the works he designed, in addition to considerable construction for private estates, are: landscaping and special work for the Imperial Exposition, London, England (1909): the structures for the Centennial Exposition at Buenos Aires, Argentine (1910); model city for the General Electric Company at Erie, Pa.; several sewerage and sewage disposal systems, and numerous buildings. He served as assistant engineer for the Lehigh Valley Railroad for three years and was engineer for the Glenside & Willow Grove Railroad and Willow Grove terminal. For the Pennsylvania and Philadelphia & Reading Railroads he served as supervising engineer on various bridges.

C. M. James, formerly assistant to the third vice-president of the Atlantic Coast Line Railroad at Wilmington, S. C., has been appointed engineer of construction.

C. J. Chenworth, formerly engineer of roadway for the Atlantic Coast Line Railroad at Savannah, Ga., has been appointed assistant to the third vice-president at Wilmington, S. C., succeeding C. M. James, whose appointment to another post is noted elsewhere in these columns.

F. V. Berkey, formerly assistant engineer on the central division of the Pennsylvania Lines West of Pittsburgh, has been appointed assistant engineer on the St. Louis division of the Vandalia Railroad.

Guy A. Rupp, formerly connected with the maintenance-of-way department of the Lehigh Valley Railroad, has been appointed constructing engineer for the Pennsylvania Trojan Powder Company at Allentown, Pa.

Anthony J. Bemis has been appointed general manager of the Public Utilities Company of St. Cloud, Minn.

Claude L. Van Auken, formerly employed in the valuation department of the Chicago, Milwaukee & St. Paul Railway, has been appointed assistant engineer on the valuation of Chicago Terminals for the Chicago, Rock Island & Pacific Railway.

O. E. Carr, formerly city manager of Cadillac, Mich., has been appointed city manager of Niagara Falls, N. Y.

Arthur W. Kreinheder has been elected commissioner of public works of Buffalo, succeeding the late Col. Francis G. Ward.

George H. Norton, deputy engineer commissioner of the Department of Public Works of Buffalo, N. Y., was unanimously elected city engineer of that city at a meeting of the councilmen held Jan. 6. Mr. Norton was graduated from Cornell University in 1887, and first engaged in practical work as a rodman and leveler on the Duluth, South Shore & Atlantic Railroad. He entered the service of the city of Buffalo in 1898 as assistant engineer. He was appointed deputy engineer commissioner of the Department of Public Works in 1909.

Frank P. Cobb has been reappointed city engineer of Chicopee, Mass.

Ralston H. Willis, formerly inspector of concrete roads for the Association of American Portland Cement Manufacturers, has been appointed assistant on the engineering forces of the Pittsburgh division of the Pittsburgh, Cincinnati, Chicago & St. Louis Railway. He was graduated from the University of Pennsylvania in 1915.

Ellis R. Goldman of the city engineering department of Rockford, Ill., has been appointed assistant superintendent and engineer of the water department.

Obituary Notes

S. Foster Jacques, assistant city engineer of Binghamton, N. Y., and municipal engineer for Johnson City, was killed in a motorcycle accident Jan. 8. His technical training was received at Massachusetts Institute of Technology. He went to Binghamton about ten years ago to handle the installation of a sewerage system for the village of Lestershire, and, on the completion of that work, entered the city engineer's office in Binghamton. Previous to this service he was in the city engineering department of Worcester, Mass. While there he was engaged in some of the pioneer work in sanitary sewage disposal. Later he engaged in private practice for about three years in Dover, N. H., following which he spent several years on engineering work in the South.

William W. Follett, a well known engineer of the Southwest, died at his home in El Paso, Tex., Dec. 30, 1915, at the age of fifty-eight. Mr. Follett was at one time consulting engineer under the Geological Survey in the investigation of the proposed international dam project for the Rio Grande near El Paso. Later he was appointed consulting engineer of the American section of the International Boundary Commission, United States and Mexico and for some years served as consulting engineer for the El Paso & Southwestern system in planning the water supply from the White Mountains of New Mexico. He was afterward tendered the position of consulting engineer for the Elephant Butte project and the El Paso Valley Water Users' Association, but was unable to accept it owing to ill health. He received his professional education at the University of Michigan and was for several years engaged in railway work on the New Orleans & Northwestern, the Vicksburg, Shreveport & Pacific and the Atchison, Topeka & Santa Fé. He was consulting engineer of the International Boundary Commission for sixteen years, resigning from the office in June, 1914, and being succeeded by H. P. Corbin.

James K. Wilkes, formerly chief engineer of the Department of Public Works of New Rochelle, N. Y., died in that city, Jan. 8. He was born at Danbury, Conn., in 1859. His first engineering work was as assistant to D. G. Penfield, civil engineer, of that city, from 1880 to 1884, on general work including the construction of the New York & New England Railroad between Danbury and Hopewell Junction, N. Y. In the latter year he was appointed borough and city engineer of Danbury. He entered the service of the City of New Rochelle in 1890 as assistant engineer in charge of sewer construction.

Albert Wilber, former city engineer of Herkimer, N. Y., died in Syracuse, Jan. 5. Mr. Wilber spent the greater part of his life in railroad construction. Five years ago, he was appointed city engineer of Herkimer, which position he held two years, retiring then from active work. He was seventy-six years of age.

Oliver C. Gayley, vice-president of the Pressed Steel Car Company of New York City, died in New York, Jan. 9. Mr. Gayley started his business career as a civil engineer and served for eight years in the engineering department of the Pennsylvania Railroad. Later he was a division engineer on the Philadelphia & Reading.

Civil Service Examinations

United States.—An examination for surveyor, salary from $90 to $150 per month, is to be held Feb. 2 and 3 at the principal cities of the states. This position is in connection with the engineering department of the War Department. The requirements include mathematics to plane trigonometry and use of logarithms or slide rule, plane surveying and drawing. Applicants must be 20 years old and less than 40. Technical school graduates will receive credit, as well as those who have had more extensive experience.

Chicago.—The Civil Service Board announces an examination for rodman, salary from $40 to $75 per month, to be held Jan. 26. This examination is open to non-residents, who must be over 18 years of age. The subject pertains to the important features of surveying.

Examinations Previously Announced

United States.—Civil Engineers, Philippine Service, salary from $1,800 to $3,000 a year, to be held Jan. 18; sanitary engineers, Bureau of Science, Manila, P. I., salary $1,600 a year, to be held Jan. 19; and structural engineer and draftsman, Supervising Architect, Treasury Department, salary $1,800 a year, to be held Jan. 19-20 (See Engineering Record, Jan. 1).

New York.—Architectural draftsman, salary from $1,201 to $1,500 a year, to be held Jan. 22 (See Engineering Record, Jan. 1).

Business Notes

The Bailey Meter Company, 141 Milk Street, Boston, has been incorporated to manufacture and sell a complete line of recording meters for power plant and similar uses. The meters have been developed during the past six years in the mechanical engineering department of the Fuel Testing Company of Boston. E. G. Bailey, of the latter company, will devote his entire time to the new company. The work of the Fuel Testing Company will be under the direction of W. B. Calkins. The Bailey meters are adapted, it is claimed, to accurately measure steam, water, air and gases.

Leroy A. King has resigned from his position as sales manager of the road machinery department of the Wheeling Mold & Foundry Company of Wheeling, W. Va.

The American Rotary Valve Company of Anderson, Ind., has discontinued the manufacture of electric motors, press drives and vacuum cleaners to devote its entire effort to the manufacture of the Arvac universal joint. Orders in hand for the former products will be filled and the company will continue to provide repair service on them.

Walter H. Bell, formerly with the Kettle River Company, has been employed by the National Lumber Manufacturers' Association under the direction of E. A. Sterling, manager of the trade extension department. He is to visit retailers and co-operate with them in teaching the public the best uses of wood.

Ralph S. Townsend, formerly superintendent in the road oil department of the Atlantic Refining Company in eastern Pennsylvania, is now connected with the sales department of that company, covering Eastern New England, in the interest of asphalt and bituminous products. His headquarters are in the Turks Head Building, Providence, R. I.

William E. McDonald, treasurer of the Flynt Building & Construction Company of Palmer, Mass., died Dec. 11, 1915.

William Claflin Andrews, advertising manager of the Edison Storage Battery Company, Orange, N. J., died in New York City, Dec. 21. After graduating from Columbia University, Mr. Andrews became sales engineer for the Stanley Instrument Company of Great Barrington, Mass., and later was connected with the General Electric Company in Schenectady, N. Y., and Harrison, N. J. He was for two years secretary of the Rae Company, New York City, leaving that office to join the Edison Storage Battery Company in April, 1913.

T. L. Hughes has been appointed district sales manager of the Lehigh Portland Cement Company of Chicago, at New Castle, Pa., succeeding P. A. Jandernal, resigned.

J. S. Cabanis, formerly with the Ludowici-Celuden Company, Minneapolis, has become assistant manager of the Chicago office of the Atlas Portland Cement Company.

The A. Lietz Company, San Francisco, makers of civil engineering instruments, is opening a new office at 61 Post Street, San Francisco. The head office will be moved to the new location, which will be fitted up as a show salesroom, thus giving additional space in the company's factory at 632 Commercial Street.

Trade Publication

Holyoke Machine Company, Holyoke, Mass. Catalogs 11 and 13, 6 x 9 in., 28 and 64 pages respectively, illustrated. The first catalog deals with head gate hoists, illustrating numerous patterns. The second catalog, which is more comprehensive, covers water-power generation and transmission, the most important feature of which is the Hercules turbine. Special types of this turbine are treated in considerable detail, tables showing their horsepower, cubic-feet-per-second performance and revolution per minute for sizes of from 9 to 60 in., and of heads from 3 to 12 ft., covering turbines ranging from 0.6 to 3274 hp. being included.